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Reclamation for extension of John Summers & Sons Ltd. Steel Works at Shotton

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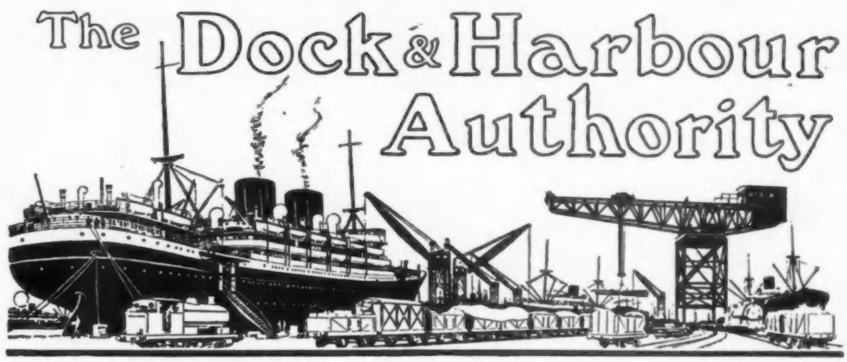

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The Dock & Harbour Authority

An International Journal with a circulation extending to 85 Maritime Countries

No. 467

Vol. XL

SEPTEMBER, 1959

Monthly 2s. 6d.

Editorial Notes

Berth for Supertankers at Finnart, Loch Long.

The official opening, on the 9th June last of No. 2 Oil Jetty at Finnart called attention to the possibility of regular arrivals in Europe of supertankers of up to 100,000 DW-tons. Although the use of such vessels for transporting crude oil from the Persian Gulf to Great Britain is not immediately anticipated, the deep approach channel of Loch Long and a depth alongside the berth of 55-ft. at low water of ordinary spring tides, will allow the routine berthing of vessels of this size.

Our leading article this month describes in detail the engineering aspects of the construction of the new jetty and of the ancillary installations. The new terminal is an extension of an existing one which has been in operation since 1951, and the owner is to be congratulated upon the care with which the loveliness of the area has been preserved. Although the main road to Arrochar passes through the terminal land works, the public sees little of the storage tanks, pipe tracks, pump houses and buildings, which are masked by plantations of flowering trees and shrubs.

The article describes both the marine works, comprising jetty, dolphins and bollards, and the land works necessary to collect and pump away ship's cargoes through a 60-mile long pipeline to a refinery on the East coast of Scotland. The need for additional tankage is explained and an interesting account is given of the problems which were met in its design and construction. The design of the jetty was greatly facilitated by the steeply shelving shoreline, and the owner is fortunate in being able to adopt a scheme which, while providing a berth of the very largest capacity, must also have been very economical in first cost. The jetty head, 330-ft. long, is strutted from the shore, the struts being designed to transmit the longitudinal component of the berthing loads of the largest tankers. An approach speed of about seven inches per second has been considered adequate as a basis of design in this locality where the assistance of tugs is also available for berthing. The main fenders are sized accordingly, and reference to the text indicates that these do not appear to be designed to carry major glancing blows or to withstand heavy fore-and-aft rubbing action by a moored vessel.

No doubt, however, the limited angular displacement of the fender head, to which attention is drawn, is designed to have particular reference to the conditions at Loch Long, and an interesting fendering scheme, which appears to be economical in first cost, has been evolved. The article includes an account of the construction methods and programme, and gives practical details of any unusual procedures adopted and of the steps taken to overcome certain constructional difficulties which were encountered.

Throughout the world, a number of supertanker berths are being constructed by, or are coming within the purview of, Port Authorities, and we look forward to publishing in future issues technical details of various large berths, either planned or under construction. We are indebted to the British Petroleum Company Ltd., for the present article and would call particular attention to the oil/water separation and the fire-fighting equipment, as both subjects are becoming increasingly important.

The Administration of Terminal Facilities.

Although all new things are not necessarily good, nor are old things invariably bad, there is room in almost every enterprise for critical examination of method in order to decide whether custom alone is sufficient justification for doing things in a particular way. Nowhere does this apply more than in the port transport industry which will be thought by many to have lagged behind other industries in adapting itself to changing conditions and where there is often too much rather than too little in the way of available facilities and a great deal of it not economically viable.

The "Poseidon" article, "A Remedy for Dock Strikes", and the subsequent correspondence upon it which was published in October 1958 and in succeeding issues of this Journal gave point to this. Although this most instructive discussion produced a lot of thought-provoking argument, nothing really practical or constructive emerged. It showed more than anything, however, that the problem of port labour was rooted in the structure of the industry as a whole and could not properly be considered in isolation from it. It was with this thought in mind that we reprinted in our issue for last month a description of the licensed wharfingering system employed at the Port of Melbourne.

This thesis is developed further in an article by a contributor which we publish in this issue. A certain interest has been given to it by Mr. Justice Diplock's recent judgement in Midland Silicones Ltd., v. Scruttons Ltd. The judgment in this test case consists of a careful review of the various authorities and the conclusion that the decision of Lord Justice Scrutton in a 1925 English action was incorrect. In the 1925 case Lord Justice Scrutton took the view that an agent could rely on clauses contained in contracts made between the principal and a third party and in the light of that decision many port authorities have framed their By-laws and determined the form of the receipt they give.

The latest decision may have far-reaching implications; it would seem to emphasise the desirability of relations being established on the basis of contractual rights and obligations rather than by reliance on the validity of By-laws. The scope of contracts must first be defined, however, and in doing so an opportunity might be afforded for a rational division of the whole area of performance into phases where each operation can be concluded in a manner which facilitates the performance of the next in sequence. Thus, duplication of effort and resulting misunderstanding and dispute might well be avoided. This is broadly the theme of the paper we publish and the study pro-

ceeds with the establishing of zonal authority with a system of indirect control permitting genuine consultation in each sector but having as its main objective the virtual separation of (ocean) wharfinger operations, associated with the international business of sea-carriage, from non-wharfer operations which must be regulated largely by domestic economic and social considerations. This last may be of especial importance to sea communications when examined in the context of a developing Commonwealth.

The scheme, in essence, proposes a framework of private enterprise working in harness with public regulations which, taken to its conclusion, might well influence the design of ships, the layout of wharves and (what is most important) the formation of a healthy social structure within the industry. Our contributor has emphasised that the study represents a philosophical attitude rather than a precise plan of action, for the finding of common ground based upon a reconciliation of divergent British and American shipping practice requires the widest area of consultation and agreement. Nor does the need or desire for reform press everywhere with equal weight. Nevertheless the attempt is well worth making.

Most of the paper is taken up with the public policy aspect of conducting an essential service, which is of paramount importance. Unfortunately, pressure on our space compels us to print it in two parts; the first is concerned predominantly with general administrative and legal considerations and forms a useful conspectus of the situation, while the second part, setting out the further implications of the argument, must unavoidably be held over until our October issue.

It is hoped that an objective study of this kind and scope will earn the critical attention of our readers. Certainly, in the field of port working, where there is no commonly accepted basis of costing, no uniform method of assessing charges or deciding their incidence, no common terminology even, we believe that this paper will serve a useful purpose if only to focus attention on the desirability of establishing some guiding principle which will assist the development of the industry.

Pension Scheme for Dock Workers.

Meetings between port employers and the trade unions, held at the end of August to discuss a pension scheme for dock workers, have resulted in agreement in principle between both sides of the industry.

This matter was briefly referred to in our last issue and the decision to introduce a contributory pension scheme early next year, as announced by the National Joint Council for the Port Transport Industry, has been generally welcomed as an innovation which should ultimately lead to better labour relations at the docks.

Following the announcement, Mr. A. J. M. M. Crichton, chairman of the National Association of Port Employers, said that the main outlines of the scheme had been considered and it was now intended to work them out in greater detail, and to place them before the unions to obtain their reactions. It is understood that details of the benefits have not yet been fully worked out but it is tentatively suggested that a new entrant at the age of 25 would receive a pension of 40s. after 40 years service, and men in the higher age brackets an allowance of 10s. a week plus a capital sum of £100 on retirement; in between these limits it is planned to increase the weekly allowance from 10s. but to decrease the capital allowance. The allowances will be additional to whatever the men might receive from other sources. An immediate retirement age of 70 is proposed which will gradually be decreased to 65, and it is suggested that the contribution from the men should be 2s. 6d. per week.

The employers have informed the unions that they will bear the entire cost of the deficiency payment which will be necessary to meet the position of the older men retiring, and it is anticipated that this liability will be at least twice the half-crown the men will contribute. The employers also propose that all young men entering the industry shall undergo a proper medical examination, as is already the case at many ports. There will also be a training scheme for new entrants, in which the unions will jointly participate, beginning with pilot schemes, probably in London and Liverpool. This will be part of a streamlined policy to promote greater efficiency and is also aimed at assuring the men that, with their full co-operation, they can look forward to greater regularity of work and good earnings.

Speaking on behalf of the unions, Mr. T. O'Leary, national dock secretary of the Transport and General Workers' Union, said that he considered the scheme to be a milestone in the industry's history. He hoped that it would provide a more satisfied and a more productive industry and so contribute to the national well-being. With the ability to retire the older men, room would be made for younger men and newcomers would be offered an industry which would be prepared to take care of them when they, in turn, came to retire.

Stressing that the scheme was a voluntary one for those at present working in the docks—it will be compulsory for new entrants—Mr. O'Leary added that the trade unions hoped that all men now working would join the scheme. According to figures issued by the National Dock Labour Board, there are about 72,000 men on the workers' register, of whom 5,700 are over the age of 65.

Port of Melbourne Traffic, 1958.

The 82nd annual report of the Melbourne Harbour Trust Commissioners states that the volume of trade during 1958 exceeded eight million tons of cargo for the fourth year in succession, and a total of 2,632 ships were berthed with a gross tonnage of 16,280,433. Imports for the year totalled 6,370,862 tons, the highest since 1955 and an increase of 379,866 tons over 1957. Exports amounting to 2,001,493 tons, however, showed a decline of 205,322 tons.

The report points out that over the past four years the speed with which non-bulk cargo has been handled per day in the port has steadily increased, resulting in a faster turn-round of ships. In 1958, vessels spent an average of 4.1 days in port to handle non-bulk cargo, and the average quantity of cargo loaded or discharged per ship was 1947 tons. The average daily rate of handling was 478 tons. Compared with 1954, ships spent an average of 32 per cent less time in port during the year, while the rate at which they handled their cargo showed an average increase of 27 per cent. Although the average tonnage of cargoes handled by the ships in the port was lower than in 1954, it was nevertheless the faster cargo handling rate which was the big factor in the more rapid turn-round of vessels.

With regard to port development, work on a new passenger and cargo terminal was started during the year when bores were sunk to explore the foundations for a berth for the new roll-on, roll-off ferry service between Melbourne and Devonport, Tasmania, which is expected to be inaugurated by the end of 1959. In conjunction with this work, a start was also made on the construction of three 16-pile dolphins against which the vessels will be moored.

Considerable reconstruction, modernisation and maintenance work was continued during the year in Victoria Dock, the port's main oversea cargo terminal. The extension of the western side of Station Pier, Port Melbourne, was completed during the year with the installation of special railway points and surfacing of the new concrete deck. This extension of the pier by 130-ft. is to cater for the new passenger liners over 800-ft. long which are expected in the port during the next few years. Further progress was also made with the construction of an 80-ft. extension of the upper concourse, to cater for the passengers embarking and disembarking from the new liners.

Finnart Ocean Terminal

Engineering Aspects of Construction

(Specially Contributed)

General Description

In 1949 the BP Company, then the Anglo Iranian Oil Company, were expanding their Refinery at Grangemouth so as to obtain a throughput of approximately 2,100,000 tons per annum (2.1 m.t.a.). Up to that time all crude oil from abroad for that Refinery had been brought to Grangemouth by tanker via the Forth River and Grangemouth Docks. While the docks themselves could have handled this increased throughput, there were severe limitations on the size of tanker that could use the River Forth up to Grangemouth. The company therefore looked for a new port that could handle large tankers with a view to comparing the cost of developing such a port, together with the associated pipeline to Grangemouth, with the cost of dredging a channel in the Forth River. This economic assessment included, of course, running costs and continued dredging of the River.

After considerable search and estimation it was decided to develop a sea terminal at Finnart on Loch Long. This is on the west coast of Scotland and approximately 60 miles distant from Grangemouth. As a consequence of this, it was necessary at that time to lay a pipeline from Finnart to Grangemouth as well as to build a jetty, tankage, pumping station, etc., at Finnart. The pipeline was sized adequately to handle enough crude oil to supply Grangemouth with approximately 3.5 m.t.a.

At that time the maximum size ocean-going tanker that was envisaged was about 28,000 d.w.t. and the jetty was located so as to give at least 34 feet of water at all states of the tide. As events proved this is sufficient for tankers of 32,000 tons d.w.t. and doubtless could be used for even larger ones.

Associated with the jetty is an oil storage depot to act as a buffer since it would obviously be uneconomical to pump through a long pipeline at the same high rates that sea-going tankers discharge their cargoes. The tank farm in this depot consisted of four crude oil storage tanks each holding 20,000 tons of crude oil (6 million gallons) and two tanks each of 10,000-ton capacity for storing fuel oil and diesel oil bunkers. Other aspects of the depot were fire fighting services, drainage arrangements, pipelines, etc., as well as the main pumphouse for forwarding the crude oil to Grangemouth.

This pumphouse contains two motor-driven centrifugal pumps each individually capable of pumping approximately 250 tons per hour of crude oil at 800 p.s.i. As stand-by capacity there are three No. 90 tons per hour reciprocating and three No. 60 tons per hour centrifugal pumps, all driven by diesel engines.

The two main centrifugal pumps when run in parallel and worked in conjunction with a booster station half-way along the line to Grangemouth will deliver approximately 430 tons per hour, the actual amount depending on the particular crude oil, temperature, etc. Taking into account the inevitable delays and bunching in tanker arrivals and non-pumping periods, this is equivalent to approximately 3.5 m.t.a.

Early in 1957 serious consideration was being given to the use of tankers of capacity far in excess of 32,000 tons d.w.t. and it was decided to modify the terminal at Finnart so that it could handle tankers up to 100,000 d.w.t., with the expectation of 65,000 ton vessels being regular users.

One of the main reasons why Finnart was chosen for this was that approximately 55ft. of water at LWOST could be obtained only 200ft. offshore. The cost and time required to provide for such a berth was, therefore, less at Finnart than elsewhere. Moreover, all the facilities required for an ocean terminal already existed at Finnart and many of them merely needed extension in order to cover the new jetty and tankage.

It will be appreciated that the existing 80,000 tons of crude oil storage capacity was not sufficient to handle cargoes of even 65,000 tons, particularly bearing in mind that it is seldom possible to mix crude oils from different sources. It was, therefore, decided to provide a further 80,000 tons storage capacity in four tanks adjacent to the new jetty. It will be seen from the General Site Plan that the new tank farm and jetty is separated from the old site by the County Road A847. Nevertheless the two sites are integrally joined by pipelines, services, etc., and the whole terminal operates as a single unit.

LANDWORKS

Tankage

All the tanks at Finnart are of welded steel construction with floating pontoon roofs. This type of roof helps to diminish the fire hazard as well as confining losses by evaporation to a minimum. The tanks are sited in pairs in basins on the steeply sloping hillside and this caused considerable civil engineering work on site. It is accepted practice that where more than one storage tank is sited in a single basin then the volume of the basin must be at least that of one tank plus 10% of the remainder.

In this case there are two tanks in each basin and an economic mean had to be struck between cutting into the rock hillside to give greater area of the basin and building up the bund to give greater depth to the basin. Eventually a bund 20 feet above the basin and tank floor was decided upon as any greater height would have increased the problems of stability and would also have made smaller the area for the pipetrack. The General Site Plan illustrates this problem and shows that even at this height it was necessary to provide a firm toe to the embankment at low water level. In order to avoid extensive work on this toe at levels below LWOST it was sited so that it was never below minus 2.5 OD and the line of the road, pipetrack and bund follows this in plan. Beneath the bund the topsoil was removed so that the rock fill was placed direct on the sub soil rock and where the latter was smooth it was chased and benched to give a rough non-slip surface.

With the tankage so close alongside the sea it was considered necessary to design this tank farm so that there was no possibility of spilt oil finding its way through either ground fissures or porous bunds.

The problem was accentuated by the fact that all the rock was a mica schist which was highly foliated and fissured while the bunds had to be built up of the excavated rock. As a consequence the inside of each basin was sealed with a concrete membrane. Over the floor and face of the bund this took the form of a concrete slab 4in. or 6in. thick, but the irregular face of the excavation in rock was sealed with mass concrete behind a 4½in. brick wall. Apart from acting as

shuttering for placing the concrete this brick face takes care of any temperature movements that might occur and prevents the mass concrete from cracking.

Drainage

An essential feature of any oil depot is that no oil-contaminated water should be discharged to waste and great care is always taken to ensure this. Finnart is situated in a district where rainfall is very high and as the cost of separating oil from water is expensive the first essential was to ensure that no rainfall run-off was contaminated if it could be avoided. Cut off drains are therefore provided above all the tank basins and the water thus trapped is diverted direct into the sea. All potentially contaminated water is led into one of two oil/water separators designed to the A.P.I. Code of Practice. From there clear effluent is discharged to the sea while recovered oil is pumped back into the main oil pump suction lines. Areas which discharge to the separators include the tank basins, valve manifold pits, and jetty deck.

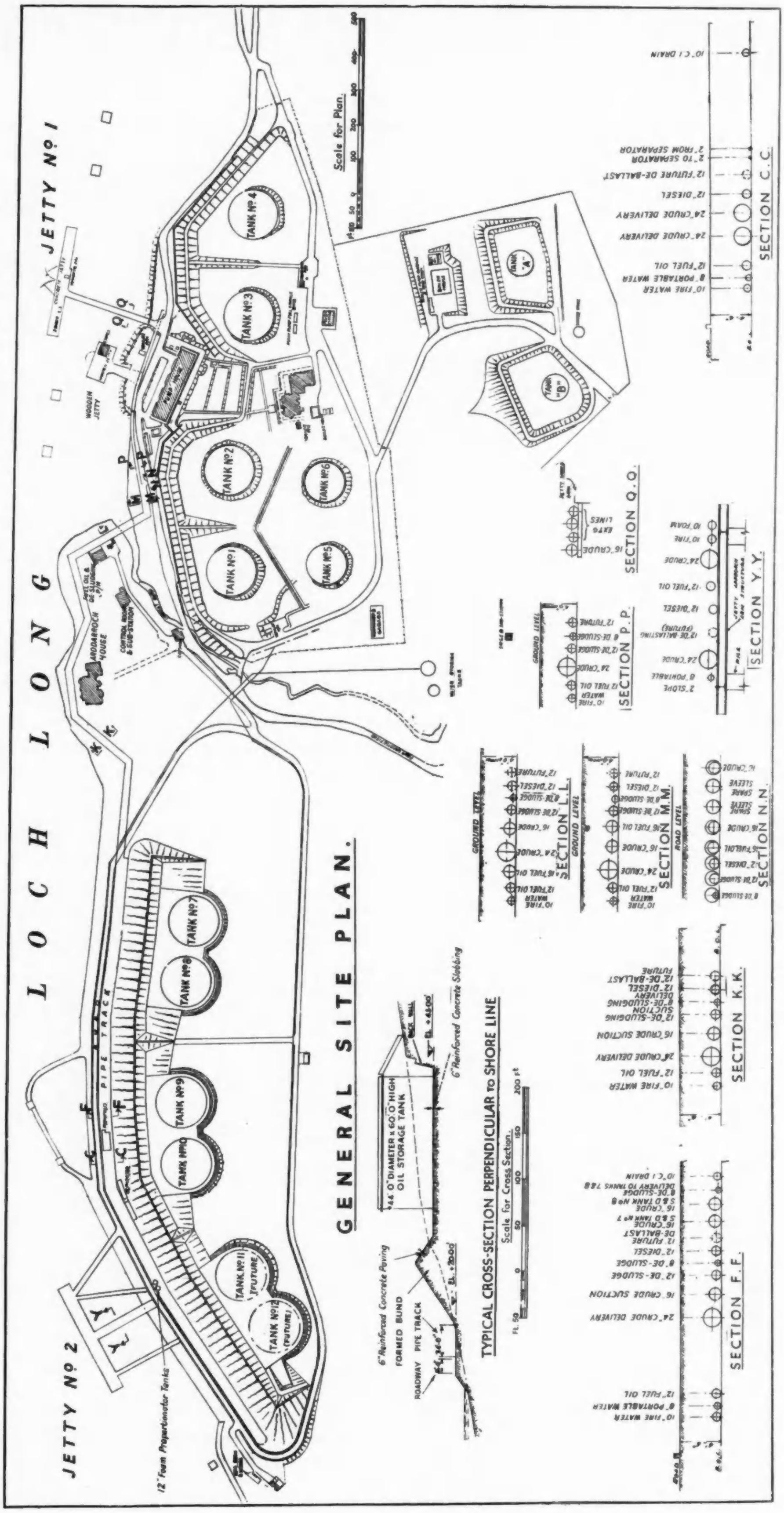
Electrical Works

Crude oil is a potentially hazardous fluid to handle as the gases are highly inflammable and form an explosive mixture in a wide range of proportions with air. All electrical equipment in the Terminal, except in two clearly defined small areas, is therefore flameproof and is Buxton certified as safe for use with Group II gases. This not only applies to motors, driving pumps and other machinery, but also to all lighting, heating, switches, etc.

Instrumentation and Controls

It is, of course, an expensive waste to keep tankers tied up longer than absolutely necessary and most tankers have their discharging pumps sizes so that they can complete the discharging of their cargo in approximately 15-20 hours. With a very large tanker of, say, 100,000 tons d.w.t. this means that the Terminal must be capable of receiving oil at a rate of up to 6,000 tons/hr. This is too high a rate to discharge into a single storage tank and it was therefore accepted that three tanks would be used simultaneously and even so the rate of filling will be such as to need remote indication of oil levels and remote control of main valves. A control panel has been placed in a building central to the old and new tank farms and the amount of oil in each of the storage tanks and two bunker tanks is continuously indicated on this panel. Level indication is provided by Evershed & Vignoles' Precise Level Indicators.

The main inlet valve to each tank is electrically motivated and is operated from the Control Panel. To prevent the possibility of overfilling a tank a high level alarm system



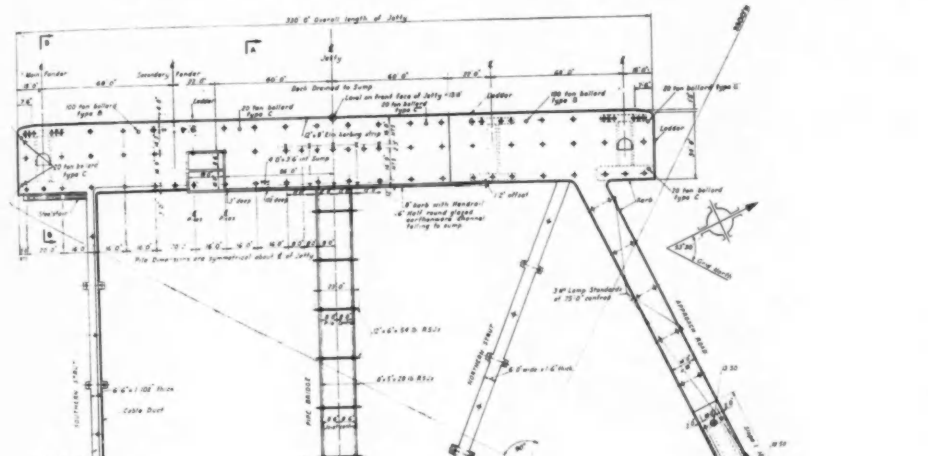
Site Plan looking North-West—also showing typical cross sections.

is also incorporated and as a "last ditch" control against overfilling a mechanical switch operated by the rising floating roof of each tank automatically shuts the main valve to that tank. The electrical interlocks are such that the valve cannot be opened again except by hand operation until the level of oil in the tank has fallen to a predetermined safe level.

Firefighting Services

As stated previously each storage tank has a floating roof and this, together with adequate electrical earthing, reduces the fire hazard at the tanks to a minimum. However, a fire main operating at 150 p.s.i., surrounds the tank farm and each tank can be covered by several hydrants, and equipment is provided to apply 6.000 gals./min. of foam to any tank. Total foam output may be boosted to 20,000 gals./min. or more in the event of a major fire.

Rather elaborate precautions, however, have been taken at the jetty. Here four monitors have been fitted at a level approximately 50ft. above the jetty deck so that each can play down on to the deck of even the largest tanker lying alongside. The pipelines and fittings to these have been sized so that a total of 2,000 gals./min. of water or 8,000 gals./min. of foam can be applied. Foam compound is supplied and mixed with the correct proportion of water from a twin proportionator situated at the root of the pipebridge to the jetty. Aeration and expansion takes place in the riser to each individual high level monitor. As a safety precaution these monitors can be operated and directed from deck level as well as from the platform at high level.



Arrangements and general details of No. 2 Jetty, Finnart.

MARINE WORKS
JETTY

General Design Notes

Site conditions exercised a considerable influence on the design. The site provides deep water within 200 feet of the shore, but concomitant with this, is a steeply shelving bottom. Test piling showed that the overburden was very little, and that the rock also shelved steeply at approximately 3 : 1. During test piling, shod piles tended to "wander" on this slope and, consequently, open ended piles were adopted. The small penetrations achieved during testing also showed that raker piles would not be practical and, consequently the jetty was designed as a completely rigid structure.

All pile loads are vertical, and transverse loads are carried back to shore through R.C. Struts, which are anchored in solid rock. The length of pile involved also governed, to some extent, the choice of pile material. R.C. piles would have been extremely heavy, and subject to the "wander" mentioned earlier. Open ended steel piles were therefore used.

Messrs. Rendel, Palmer and Tritton were appointed as Consulting Engineers for certain limited civil engineering work in connection with the construction of No. 2 Jetty. They prepared designs, specifications and working drawings to the overall basic requirements of the Company. They did not provide any of the Resident Engineer's staff, which was fully under the control of BP.

Jetty Head

The jetty head deck level on the cope is at +13.00ft. above Liverpool datum (mean sea level).

The pile spacing is at 16ft. centres longitudinally and each bent consists of three piles (except at the fenders). The transverse spacing from front to rear is 14ft. 3in. and 14ft. 9in., this being done in order that the main contractor, Messrs. Melville, Dundas & Whitson, could utilise the roller shutters which were available from a previous contract.

Four Bays, each 20ft. wide, have been provided for fender housings, the main fenders having six piles in front and three in the rear, and the secondary fenders four in front and three in the rear. These front fender piles are the most heavily loaded, the estimated load being 92 tons per pile.

The jetty head consists of an "in situ" R.C. deck, 330 feet long by 36 feet wide, having a depth of 24 inches at the berthing face and 18 inches at the back. This provides a 6-inch fall on the top of the deck slab and, except for 120 feet in the centre

portion of the jetty, all drainage is direct to the sea. This 120-feet stretch is drained to a channel which runs to a sump behind the hose-handling structure. The sump has a capacity equal to one hour's rainfall at a rate of ¾in. per hour and is fitted with a vertical spindle pump with automatic "Noflote" control delivering to an oil/water separator on the shore. Access from the sea is provided by a landing stage and stairway at the back of the Southern end of the jetty and three vertical ladders, two on the berthing face and one on the Northern end. Life chains are also provided on the seaward and the end faces of jetty head.

Fender Design

To absorb normal berthing impacts the jetty head is provided with two main (outer) fenders and two secondary (inner) fenders. The main fenders are 300 feet apart and the secondary fenders 164 feet apart and are equidistant from the centre line of the jetty.

The fenders are of the buffer type, having rubber blocks made by Messrs. Leyland and Birmingham Rubber Co., as a medium for energy absorption.

Each main fender has a steel framed head 14ft. x 14ft., faced by greenheart timber 10in. thick. Behind the head are four rubber blocks, 20in. diameter and 20in. long, spaced symmetrically and bearing on the front plate of the telescope. The main rubbers are two in number, 32in. diameter and 32in. long, assembled in series within the telescope.

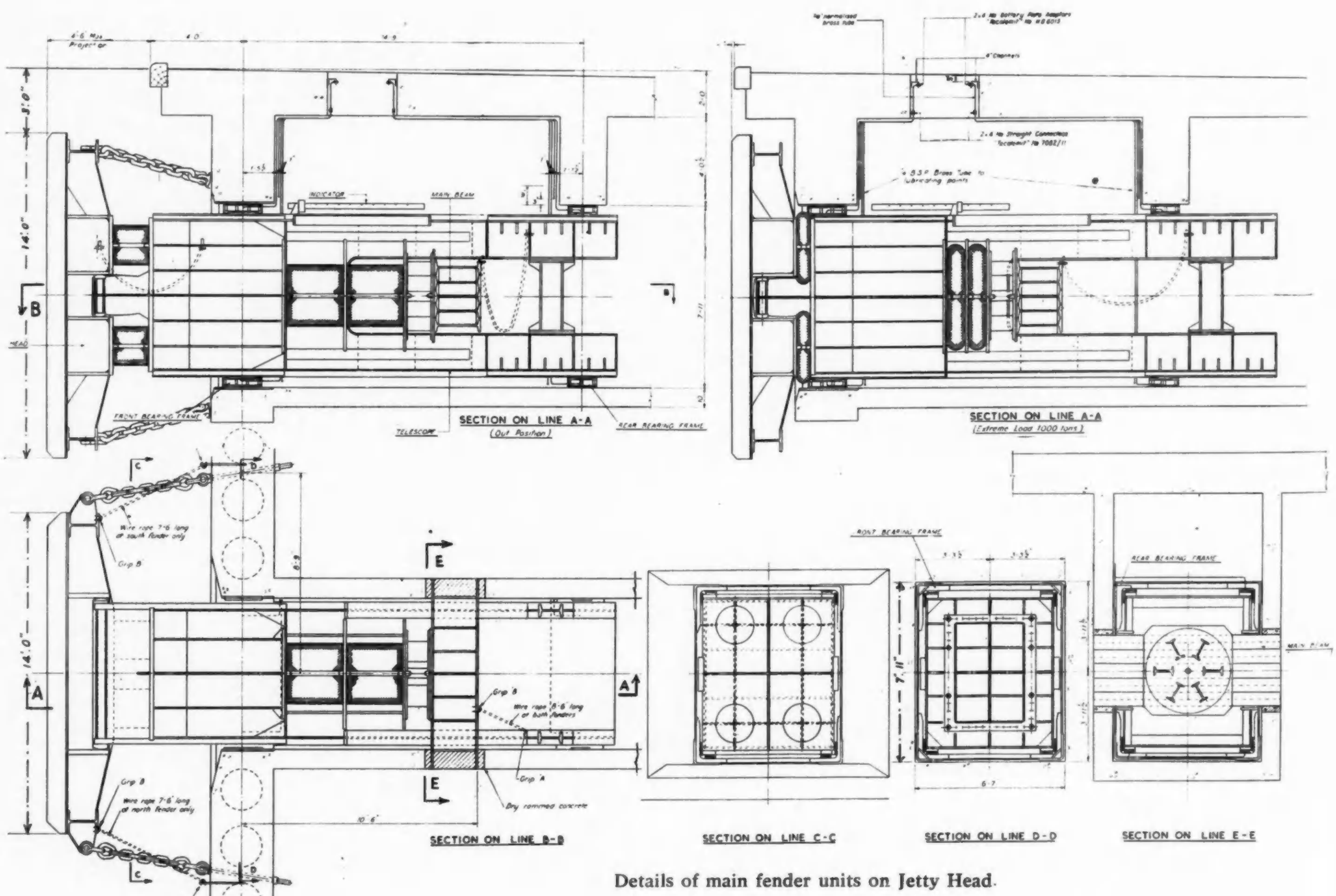
An initial compression of 4in. is maintained by chains from the jetty to the fender head and the maximum projection in this position is 4ft. 6in. A stroke of 3ft. 9in. causes a 60% compression of the two 32in. diameter blocks, giving a total energy absorption of approximately 5,500 inch tons with a thrust of a little over 400 tons. This will accommodate a 100,000 tons deadweight tanker having an approach speed of about 7in. per second, or a 65,000 ton tanker at 8.5in. per second. At 7,000in. tons energy absorption the rubber blocks are virtually solid.

The secondary fender heads are 14 feet in depth and 10 feet wide, being backed by two rubber blocks 20in. diameter and 20in. long. Within the telescope one rubber block, 22½in. diameter by 33in. long, is provided. The projection of the head with a precompression of 3.25in. is 3ft, and the relevant figures are 1,760 inch tons energy capacity with a stroke of 2ft. 3½in. and an emergency capacity up to 4,000 inch tons.

The frames and telescopes are fitted with phosphor-bronze bearing plates and a lubrication system is installed.

Anti-Corrosion Measures

As well as protecting the piles by coating with a bituminous wrap, cathodic protection has been applied to the whole structure. All piles are bonded electrically by 1in. steel bars bedded in the concrete deck slab. The dolphins north of the jetty are bonded together and to the jetty structure by the negative return lead, which is located in the cable trench. The dolphins south of the jetty are connected through resistance control to the negative terminal of the transformer/rectifier. All pipelines from the jetty have isolating flanges at the shore end of the pipe bridge to prevent current leakage. Power is supplied from a transformer/rectifier sited at the nearby sub-station on shore. The two ground beds each weigh about 4 tons and are composed of scrap cast iron. They are placed in about 30ft. of water some 300 yards south of the jetty.



Details of main fender units on Jetty Head.

Concreting around Pile Strut from Dolphin 'H'.

View along approach road showing shuttering and re-inforcing steel in thrust beams.

Hose Handling Apparatus

This consists of a steel structure supporting four No. 12in. Crude Oil booms and two No. 8in. Bunker Oil booms. In essence it provides a method of connecting the ship's manifold to the jetty manifold, which is fully flexible, and yet requires a short length only of hose. The booms, which also are pipes passing the oil, are hinged at their heel, and at their forward end carry one length of hose which is in turn connected to the ship's manifold.

Luffing swivels are located 36ft. above jetty dick, and the trunnion design is of the tubular Kingpost type located vertically on a special ball-race in the lower bracket, and a steel/bronze bush bearing in the upper bracket.

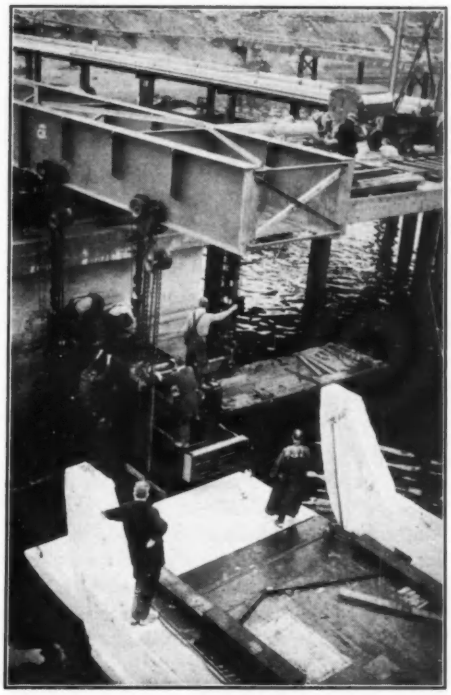
The Kingposts are extended downwards, and terminate with 360° flanged swivel joints to facilitate slewing the assembly.

Access to lower swivels and boom heel trunnion for maintenance purposes is provided from machinery platforms.

All booms are designed for use in conjunction with a single 30ft. length of 10in. bore and 8in. bore hose for 12in. and 8in. booms respectively.

Individual reversible drive units are provided for each pipe boom, comprising flameproof electric motor driving grooved winch drum through reduction gearing, and incorporating electro-magnetic brake to sustain full load when current is interrupted by accident or design, and mechanical limit gear incorporating flameproof single-pole self-resetting switches for minimum and maximum boom radius. Winch ratings are 4-tons direct x 10 H.P. and 3-tons direct x 7 H.P. for 12in. and 8in. booms respectively, with speed 20ft. per minute.

Wire line reeving is 3-fall 13/16in. diameter 6/37 construction for all booms, to facilitate standardisation.



Secondary fender telescope being inserted into housing—note method of handling.

All winches are equipped with emergency hand training gear, to permit the full operation of the boom, in the event of a power failure, and to facilitate lowering boom heads to Jetty deck for hose changing.

The push-button "Raise," "Lower" and "Stop" controls are included for each boom, one set being located on the machinery platform, about 37ft. above the jetty deck, and the others on main stanchions at Jetty deck level.

The power supply to the installation is designed to start and run a maximum of any two driving motors simultaneously.

Moorings.

Spring moorings are provided on the Jetty head consisting of two 100-ton bollards near the berthing face and 65ft. from each end of the jetty. Subsidiary 20-ton bollards are also provided, two between the 100-ton bollards and two on each of the return ends of the jetty.

On shore, near the high-water mark, breast mooring blocks are located 250 feet on either side of the centre line of the jetty. Each carries two 100-ton bollards mounted on the concrete block, which is founded directly on the rock and tied to it. One bollard has attached to it a permanent 5-inch wire with a quick release device.

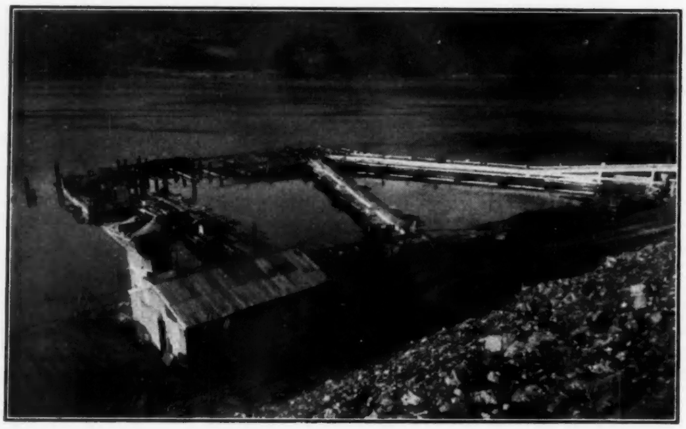
Head and stern moorings are provided by four dolphins, two at each end of the berth, each carrying one 100-ton bollard. The dolphins are of concrete slab construction carried on piles to provide a minimum water depth of 10 feet, so that they are approachable from the sea at all states of the tide. Each dolphin has a tie and a compression strut, the latter carrying a walkway with a handrail on one side to provide access from the shore. At the shore end of these walkways an additional 100-ton bollard is provided to take a standing wire as for the breast moorings.

All this work on moorings is designed for a 100-ton working load with a factor of safety of two against permanent deflection.

Approaches and Struts

The approach arm, and the northern and southern struts, transmit berthing thrusts to the shore, the approach arm and northern strut being angled to cope with any horizontal forces set up by thrusts not normal to the jetty face.

The approach arm, of concrete slab construction on piles, carries a 12 feet wide roadway, designed to take a lorry carrying a 5-ton load, to be used in emergency only.



General view of jetty with north strut and approach road concreted, shuttering for first pour in jetty head complete.

View of jetty showing north main fender head being fitted to the telescope during low water. Jetty concreting and structural steelwork of flow boom complete.

The southern strut carries a 3ft. 6in. wide walkway and a cable trench to accommodate power and telephone cables.

Both the approach arm and southern strut have handrails on either side.

Pipe Bridge

The pipe bridge is carried on bents of piles at 25ft. centres, there being two piles per bent at 16ft. centres.

The transverse beams across pile heads are 12in. x 6in. x 54lb. R.S.J.'s welded to the piles and the longitudinal members are 8in. x 5in. x 28lb. R.S.J.'s. The overall width of the bridge is 23ft. and the pipes carried are :—

2 inch	Slops line
8 inch	Water (potable)
24 inch	Crude oil
12 inch	Diesel oil
12 inch	De-ballast (future)
12 inch	Fuel oil (lagged)
24 inch	Crude oil
10 inch	Fire water
10 inch	Foam

Anchors are provided on the jetty deck for the crude oil, diesel oil and fuel oil lines, and these accommodate the loads due to friction on the pipe bridge supports and those transmitted from the shore legs.

All lines can be isolated by stop valves and are fitted with insulated flanges to prevent leakage of the imposed current in the cathodic pretection of the piles.

Jetty Construction

Pile sections were provided by the Company. In order to meet the desired delivery dates round section tubular piles had to be used. The outside diameter of all piles is 21in., and the material is $\frac{1}{2}$in. and $\frac{5}{8}$in. thick. The piles were fabricated by shop welding of 4ft. sections to form lengths of up to 40ft., the final manufacture to designed lengths being done on site.

Delivery to site was made by rail and road. In general, delivery was to Garelochhead Station, with onward transmission by road, but in some cases delivery was by road throughout.

Delivery of pile sections commenced on 16th July, 1957, and was complete by 23rd December.

Site fabrication to designed lengths was entrusted to specialist sub-Contractors and orthodox pipe welding techniques were used. Handling of pile sections was done by a 7-ton Steam Derrick Crane. Three welding bays were set up, consisting of accurately set steel rollers on concrete bases. Using these the piles could be turned as fabrication proceeded, thereby greatly facilitating the operation. M.S. Vodex Electrodes were used.

Pile sections were delivered in an unprotected condition, and a specialist sub-Contractor was employed to apply the protective coating, all of which was done on site. Each section was treated individually, and the joints made good on completion of fabrication. Two types of protective coating were specified, referred to respectively as Zone I and Zone II. Zone I protection called for cleaning of the pile (done by mechanical wire brushing). A priming coat of Wailes Dove No. 70B Primer was then applied, followed by a flood coat of No. 70B Hot Enamel. Zone II coating was similar, except that two coats of 70B Hot Enamel were applied, and fibreglass reinforcement incorporated. Zone I coating was applied to the top 40ft. of all piles, and Zone II to the remaining length.

On completion of fabrication and protection, piles were moved by light railway bogies to a second derrick: 7-ton Electric; for transfer on to a steel lighter, which was used to convey them to the piling frame.

Driving was carried out from floating plant. This consisted of a 60ft. Sykes piling frame mounted on a pontoon 60ft. x 38ft. Other equipment on this pontoon included a triple drum diesel driven winch, steam piling boiler and one small diesel winch and four hand winches for manoeuvring. The hammer was a 4-ton Single Acting. A special clamp was provided for securing the pile heads to the frame, and rubber rollers fitted to the bottom of the leaders to prevent damage to the coating. Purpose made steel helmets, fitted with plastic dollies, were used throughout. Piling commenced on 10th September, 1958, and concluded on 18th February, 1958. All piles were driven to refusal.

The last two piles to be driven, Nos. 56 and 57, which are situated at the extreme south end of the jetty in the rear row had very low penetrations. On finishing No. 57, a diver was employed to probe the bottom, and confirmed that the piles were, in fact, lying on an elevated shelf, the existence of which had earlier been suspected. Due to the location of these piles, the penetrations achieved were not acceptable, and the following remedial measures were adopted.

No. 56. A hole, 4ft. 3in. deep, and 18in. in diameter was drilled below the pile toe, and the pile re-driven 3ft. $9\frac{1}{2}$in., using a McKiernan-Terry No. 4 Hammer. The pile was then hearted with $1:1:1\frac{1}{2}$ concrete placed by tremie.

No. 57. A hole, 1ft. 8in. deep, and 18in. in diameter, was drilled as for Pile 56, and the pile re-driven 1ft. 8in.

It proved impossible to drill an 18in. hole below this depth, due, it was subsequently discovered, to the presence of considerable quantities of scrap iron on the bottom. This was eventually removed by magnet, and a 10in. hole drilled 5ft. 10in. A 12ft. long H Section steel joist was then positioned in this hole, and the pile immediately hearted with a $1:1:1\frac{1}{2}$ concrete, again using a tremie.

An extra rich mix was adopted, in these piles, because the bottoms were not completely sealed and dewatering proved im-

possible. Since some grout loss was therefore inevitable, the richest practicable mix was adopted. Grout loss was further minimized by an initial placement of lubricating grout from the concrete pump.

The drilling operations in these piles showed that only a sector of the shoe was resting on the rock bottom. Continuous "bleed" of material into the piles interfered with drilling, and was eventually overcome by an initial redrive when drilling had proceeded as far as practical. This redrive sealed the bottom. It also explains the different treatment accorded the piles. No difficulties were encountered in 56, whereas in 57 the scrap metal referred to prevented further drilling with a big bit after the redrive. An attempt to break up the obstruction, the nature of which was at the time not understood, by chisel, damaged the internal shoe, and prevented re-entry of the big bit. The smaller tool was therefore employed.

All other piles are concrete hearted with a 1 : 1½ : 3 mix. Concrete was not normally placed by tremie. Dewatering was carried out to the maximum depth possible. This proved a difficult operation on the longer piles, and the Contractors provided a number of pumps before 100% dewatering was achieved. The air-driven type of sump pump favoured, proved suitable for removing much of the silt from within the piles, as it caused considerable agitation of the water, and indeed, the emergence of silty water from the delivery line was the normal indication that bottom was being reached.

A test load was applied to one pile, No. 42. The load, of 120 tons, was applied by jacking down from Kentledge carried on a platform supported by adjoining piles. A 150-ton ship jack was used. The load was maintained for four days, and on removal complete recovery took place.

Concreting

Two types of concrete were used, a nominal 1 : 2 : 4 mix and a nominal 1 : 1½ : 3 mix.

Aggregates were obtained from pits at Balloch, some 15 miles distant. Grading analyses were conducted on dried samples, and mixes designed on the results of these. All proportioning was by weigh batching. and the designed mixes gave the proportion of 555lbs. of mixed dry aggregate per bag of cement for 1 : 1½ : 3 Concrete, and 750lbs. of aggregate for 1 : 2 : 4 Concrete. Particular attention was paid to Water/Cement ratios, and for the early pours careful tests were carried out on each occasion to determine the proportion of water in the sand, and the mix adjusted accordingly. A total water content of 9 gallons per two bag batch was adopted, although this was subsequently relaxed to 9½ gallons per batch to give greater workability and easier pumping. Once the workability and strength of the mix had been established in practice, control by slump testing was adopted. A slump of 1½in. gave workable concrete and good strengths.

All the major pours were placed by pump. The concreting plant consisted of a weigh batcher by Blaw Knox, a Kayser mixer, and a Blaw Knox pump. In practice 10 cu. yds./hr. was the best figure obtained from this equipment. Consolidation of the concrete was achieved by immersion vibrators, both electric and pneumatic types being used. The largest single pour was 137 cu. yds. All pours on the jetty proper were placed to full depth, as were those on the Dolphins, albeit the specification permitted these latter to be poured in two layers. The breast Moorings were poured in three layers.

Both normal Portland Cement, and Rapid Hardening were used. Use of the latter was permitted to assist the Contractor in achieving his target date. Results from cubes made with normal cement were generally better than those using rapid hardening.

Fenders

The fenders are telescopic, and are housed in concrete boxes carried beneath the jetty deck. The shock absorbing medium is rubber. Each fender proper is in two parts, a Head and a Telescope. The telescope is free to slide in bearings fixed within the housings. The head is carried on the front of the telescope and is free to take up limited angular displacements. These heads are secured to the housings by four chains. Shocks are conveyed from the head to the telescopes by means of two rubber blocks in the case of the secondary fenders, and four blocks in the case of the main fenders. This reaction is then conveyed to a thrust beam in each housing through further rubbers. A tolerance of ¼in. was allowed between telescope and bearings, and the latter had consequently to be fitted with great accuracy. The following method was adopted:—

The rear bearing was first fitted and held by bolts through the walls and floor of the housing. It was then plumbed, and additionally secured by steel wedges. A wooden

Aerial view of the completed terminal showing 12,000 ton oil tanker "British Swordfish" at jetty in foreground and 32,000 ton "British Glory" in background.

template made to the dimensions of the telescope was then used to check the approximate alignment of both front and rear bearings. The rear bearings were then finally secured in position, using dry rammed concrete.

This concrete had a maximum W/C ratio of .2, and was proportioned by loose volume. The proportions used were 1 cement, 2 coarse aggregate, $\frac{1}{2}$ sand. Very small quantities were mixed at one time. Compaction of the concrete was effected by pneumatic hammers.

When the rear bearing was secured, the front bearing was set to it, again using the template. Setting was checked from a centre line of piano wire, and the bearing further checked for plumbness in all planes. The levels were set by means of a water level. Cross tapping of all diagonals provided a further check on accuracy. The successful fitting of all telescopes was achieved, no snags being met.

The weight of telescopes and heads called for special lifting tackle, and this was developed and manufactured by Messrs. P. & W. McLellan of Glasgow. It consisted of a pair of plate girders, cantilevered over the deck. The root of the girders was secured to the deck by bolts and the Contractors also provided Kentledge. Lifting of the telescopes was accomplished by four 10-ton Morris Chain Blocks, working on two special beams, or strong backs, attached to the telescopes. Lifting eyes were provided on the heads.

Fender parts were transported by road from Newcastle to Greenock and from there to site by landing craft. On arrival at Finnart the telescopes were placed on roller conveyors, and the resulting mobility greatly facilitated placing. Because of the very small tolerances in fabrication and the weight of the individual parts, the placing of the telescopes in the housings called for special treatment. The following procedure was adopted:

(i) The rear pair of chain blocks were moved out as far as possible on the gantry, and attached to the rear lifting beam.

(ii) The telescope was then drawn forward on the conveyors, the load of the rear end being carried on the blocks, until the four blocks could be fitted, and the telescope fully suspended.

(iii) The telescope was then drawn into the housing by means of a tackle, until the rear blocks were hard up against the jetty face.

(iv) These were then disconnected from the telescope, and

(v) The telescope drawn further until fully entered in all bearings, when the front blocks were disconnected.

On entry of the telescope, the main thrust beams were positioned and secured with dry rammed concrete. It was found that locating these beams was greatly facilitated by first positioning the rubber blocks and spacers. The hardening period allowed to the concrete was three days, after which the telescope was compressed for fitting the head.

Conclusion

This project was ordered in February, 1957, and survey work and planning started soon after. The first tanker was berthed on the 9th October, 1958—a fact of which the Company can well be justifiably proud.

The Administration of Terminal Facilities for Overseas Trade

By P. A. T. CHRIMES, C.B.E., M.A., M.I.C.E., M.I.Mech.E.

The organisation and administration of ocean terminals has been the subject of innumerable papers and discussions. There is no consensus of opinion as to what constitutes the ideal, nor is common agreement to be expected where the local circumstances of the port and the nature of its commerce are everywhere so different. Each port must be a reflection of its own political and economic environment, yet it provides, in the main, the terminal facilities for the carriage of goods by sea, an international business in which freight and its concomitant shore service is ultimately dependent on the volume of trade and cargo space offered in a free market and is determined by shipping agreement and international convention.

(2) Sea transport is quite the cheapest way of conveying goods particularly on the long hauls, even where other means of carriage exist. Ordinarily, freight does not form a large proportion of the value of goods transported and the cost of port services is an even smaller part of freight charges. It might be thought therefore, that the scope for monetary saving through improved technical efficiency in the ports is, relatively, not large. But the most important attribute of any port is that it should be *reliable*: that the service offered can regularly be relied upon. Otherwise shipowners must embody in freight an insurance risk according to the likelihood of delays and stoppages occurring and this often may be more significant than potential working economies.

(3) The notes which follow make suggestions, not only for simplifying operating procedure and improving technical efficiency through the introduction of suitably directed incentives, but for devising a rational framework where responsibility is clearly marked; where there can be proper consultation and understanding between the real interests affected, and the right measure of control, in each working sector, subject only to the prevailing public interest. Implicit in this is the need to insulate as far as possible a closely integrated industrial complex from the interplay and pressures of party politics.

(4) These notes must necessarily be written in the context of Parliamentary institutions as understood in Britain. They prescribe a philosophical attitude, therefore, rather than the recipe for a universal remedy, but with the conviction that only in this way can genuine progress be made.

(5) The Port Authority, its composition, the manner of its appointment, is vital in any administrative method. In what follows it is deemed to be constituted as a public trust corporation, a continuing body, self-governing and self-financing within the limits of the statutory powers entrusted to it.

(6) It exists primarily to provide facilities for the promotion and development of sea-borne trade in conformity with the social and economic policies of its national government. Though an instrument of government policy it must always be permitted to offer its professional advice in matters within its competence which will assist the formation of national policy in this sector. The public interest must infuse all its actions for it will be apparent that, in furnishing an arena for the exercise of private commercial functions and enterprise, it is the primary producer and finally the general consuming public which ultimately pays for the services which are provided.

(7) Members of the Commission should be selected from those

who have an intimate specialised knowledge of the working functions of the port. It must clearly be understood that they hold office as the *representatives* of the users of the port facilities, i.e., of shipowners and merchant interests, and not as the delegates of those special interests. To use an analogy—in conformity with democratic principle, the Parliamentary representative is chosen from suitable candidates by the majority vote of the living electorate. He *represents* the interest of the living body of electors of all party persuasion but they own no shares in him. The executive of government seeks to protect what it believes to be the interest, not of the living electorate alone, which may be ephemeral and fleeting, but that of the invisible community, with all its unborn constituents, according to what it would, or might say if and when it ever had a chance to vote.

(8) So, pursuing this analogy, members of the Board should be *appointed* from people *elected* by the constituent Associations of the particular " user " interests of the port. They should be appointed for a fixed term of years, which serves to emphasise the principle that once appointed, they hold office not at the pleasure of the " primary electors," but at the pleasure of the final appointer and, whilst in office, their sole duty and responsibility is to the Board—a continuing body having perpetual succession.

(9) The Port Authority should have ownership of and control over the physical assets represented by wharves and landing places; also, it should have foreshore rights and opportunity to acquire lands necessary for future developments. All these are held in trust. It levies toll for the use of those assets which together with property rents, provide revenue for their upkeep and progressive development. It will be under statutory obligation to provide safe anchorages and safe berthing for vessels of all nations, without discrimination, but apart from such statutory duties the provision of *services* required for the working of those basic facilities should, generally speaking, be left to those who need to use them. The Port Authority in fact, must have powers, whilst retaining overall control, to delegate any of its operating functions to competent licensees. The particular thesis of this paper is that the Port Authority should endeavour to delegate to licensees all those functions falling, so to speak, within the scope of the Shipowner's contract of carriage.

(10) The internationally recognised contract of affreightment evidenced by the Bill of Lading has its origin in a standard code of practice known as the Hague Rules and has been given the force of law in the relevant Carriage of Goods by Sea Acts of the principal maritime nations. Although the physical processes of cargo transfer between ship and shore and vice versa are simple legal involvements are highly complicated by reason of the fact that the Bill of Lading is a transferable negotiable document of title. The contract of carriage has, as one of its main objects, the proper delivery of the goods by the shipping company against production of the Bill of Lading. Yet the responsibilities of the carrier in this respect cannot be extended indefinitely in time or place, neither can the cargo owner be expected to await indefinitely the pleasure of the carrier. The relations between carrier cargo owner and warehouseman must therefore be established on some conventional basis and be regulated by contract which must be seen to be reasonable. Such a convention is enshrined in what is known as custom of the port. An attempt is made here to summarise the position in a manner not inconsistent, it is believed, with the practice of English Law. Where mention is made hereafter to broad propositions or general principles of law it will of course be understood that these principles are used argumentatively in order to deduce from them what would seem to be a logical course of action, the applicability of a general principle of law in a given situation, however, must be decided by the Courts.

The Bill of Lading

(11) Under the contract of affreightment embodying Bills of Lading the carrier undertakes with the shipper to convey the importer's goods in his own vessel and to deliver them to the consignee, his agent or assigns, on production of the Bill of Lading.

(12) The Brussels Convention 1924 establishes that the Contract of carriage shall extend up to the point where the consignee can effectively accept delivery but, beyond the limits of actual sea carriage, the physical transfer of the goods to the point of delivery may be performed by servants appointed by the carrier or by the consignee. The contract of carriage will end on delivery to the consignee or to his agent. When delivery is accepted by an affording agent, e.g., the Wharfinger, such agent acts for the consignee in terms of any agreement between them, expressed or implied, authorising the agent to collect the goods from the carrier and hold them on the consignee's behalf. Likewise, by agreement between the carrier and the consignee, the carrier may hold the goods as agent for the consignee.

(13) Thus, the contract of carriage may terminate in a position between the ship and that point where the consignee can reasonably be expected to accept delivery, subject to the mutual agreement of carrier and consignee with the respective agents. Except that port custom may imply a contractual relationship between consignee and wharfinger (see under), the only substantial evidence of such contract is when the consignee, or his representative, registers a delivery order with the wharfinger and is recognised by him as holding title to the goods described, which may be at any time unrelated to the sequence of cargo movements.

(14) A general principle of law holds that a master is vicariously liable for the wrongful acts of his servant and under English law also, unless some question of contributory negligence arises, a party to a contract may recover damages in full from his agent caused by the agent's negligence. A second general principle of law is that only a person who is a party to a contract can sue or be sued on it subject, however, to certain rights reserved to implied or undisclosed principles. The application of these maxims to the contract of affreightment under Bills of Lading will require some further analysis, however, and at this stage it is desirable for the status of the stevedore to be defined, in the following way: " Stevedores are persons *not being servants or agents of the carrier within the meaning of the contract of affreightment*, engaged by the carrier to perform the physical movement of goods on board the vessel, or on the shore, under a contract incidental to but not forming part of the contract of affreightment. The carrier may appoint the wharfinger to provide the stevedoring service."

(15) Since the cargo owner is seldom in a position to take delivery immediately on discharge from the vessel the contract of carriage must clearly contemplate a further span of movement, after discharge, before it can be legally terminated. It is in this sphere of operation that the main contention arises. In general two alternative formulas are employed in Bills of Lading to meet this situation. In the first, the provisions of the Carriage of Goods by Sea Act expressly apply before the goods are loaded on and after they are discharged from the ship and throughout the entire time that the goods are in the custody of the carrier. In this case the carrier would properly hold the stevedores responsible for damage of goods, caused by any negligence of themselves or their servants, in any subsidiary contract executed with them for the purpose of transferring the goods. In the second, the carrier usually seeks to protect himself from liability for any damage caused by himself or his servants or agents after the goods have left the ship's side. Such a clause in a Bill of Lading would suggest that the regulations of the contract of carriage apply to the goods only when they are within the boundaries of the ship and do not apply when the goods are detached therefrom although, indeed,

the carrier may have custody of the goods over a wider area. Ability to contract out of the consequences of one's own negligence is, of course, a common occurrence. As applied to a bailee for gain, however, the liability for negligence is governed by what might be considered "reasonable" although it is permitted to the bailee to *limit* his liability according to what shall have been agreed with the bailor.

(16) On the surface these two forms of the Bill of Lading are highly contradictory, but the contradiction is apparent rather than real when the circumstances of their application are examined. What is asserted in the first is valid in all circumstances, however, whereas in the second it is valid only in circumstances specially contrived to make it valid, namely where agreement is implied in port custom that the cargo owner or the affording agent shall accept delivery at the ship's side. Nevertheless, a clause in the Bill of Lading denying liability after the goods have left the ship's side will be ineffective if, for any reason, the carrier ultimately affords delivery without production of the Bill of Lading: it may well be ineffective where the owner of the goods, not being either consignor or consignee, or in any way bound by the conditions of the Bill of Lading, comes forward and claims compensation for damage to the goods after they have left the ship's side but whilst they are still in transit. Because of the negotiable character of the Bill of Lading and consequent delay in its presentation, delivery is frequently given by the carrier against a form of indemnity. However, the form of the Bill of Lading and the sanction of port custom, together, have profoundly influenced the efficient conduct of the port transport industry, but which of them has been the controlling influence must largely be a matter of opinion. Succeeding sections will seek to show that the policy adumbrated by the "liberal" form of the Bill of Lading is most likely to promote efficiency while the "restrictive" form is detrimental to it.

(17) In performing the physical transfer of goods recent legal judgments have established that the stevedore, the servant of the shipowner, cannot avail himself of exemptions contained in, and running with, the contract of affreightment to which he is a stranger, and he may be sued in full by the cargo owner as third party to a subsidiary contract deemed to be executed for his benefit should he have sufficient interest to enforce his claim.

(18) In the ordinary administration of an ocean terminal the Port Authority, as wharfinger and warehouseman is often deemed to be the agent of the consignee by virtue of a commonly understood custom of the port in question (see (13)) and is tacitly expected to accept delivery on the consignee's behalf at the ship's side. Such practice cannot be binding upon the Port Authority in the absence of agreement between both parties stipulating it. Arrangements may indeed be made whereby the Port Authority as affording agent accepts service at some later stage in the cargo transfer, in which case the range of the contract of carriage is effectively extended. It will be shewn that it is essential for the efficient conduct of the cargo transfer that this be done and that the point where bailment to the carrier ceases and bailment to the affording agent begins is made explicit in the Port Authority's published regulations and general information.

(19) The point of release from the carrier's contract cannot be earlier than at the side of the discharging vessel (see (11)). It is frequently held that it should be upon the adjoining wharf apron directly the sling is clear of the ship's tackle or, where cargo cranes are employed, immediately the out-going sling has passed over the vessel's rail. When this convention prevails, custody changes at that point, whereupon the wharfinger as the agent of the consignee should prudently survey and tally the contents of the sling.

(20) It becomes a practical impossibility to undertake this with proper accuracy at that point in the circumstances surrounding a speedy despatch of the vessel—particularly so where stevedoring on board the vessel is performed by the servants of the carrier and transport and warehousing on the wharf is performed by a different set of longshoremen responsible to the wharfinger. It involves a breaking-down of the sling of cargo and segregation of its contents at a position which is critical in the overall process of discharge and it defeats any sensible mechanisation of the unloading operation which demands that a pallet-pattern is made up once in the hold, as far as possible according to Bill of Lading marks, and retained intact as a unit load throughout the landing process. This division of authority between shipboard operations and wharf operations, in itself does not make for rational method in promoting a smooth and harmonious working cycle.

(21) The institution of the Public Wharfinger as the single representative of all goods-owners enjoyed its greatest stimulus in the early years of this century. It might well be argued that it has not made the best contribution to the overall convenience and efficiency of sea transport. It does, of course, confer immense advantages on the carrier, since he is enabled to combine under the single generic term "cargo" all those separate consignments covered by individual Bills of Lading; but the owner of the goods must bear the unnecessarily high cost of moving and sorting and identifying his particular consignment and the public Wharfinger has no practical opportunity of satisfying himself that the goods for which he is assuming responsibility are actually present without delaying the despatch of the vessel and earning for the port an injurious reputation for slow work.

(22) It must be recognised that the entire stevedoring operation must coincide with the performance of the contract of carriage and that the completion of each must be at the point where the consignee can reasonably be expected to accept delivery; where, in fact, an accurate tally of the contents of the sling can be taken, removed from the distraction and harassment of mid-discharge. A little reflection will show that unless the ocean contract of carriage can *legally* be terminated at the ship's side (practicable only where the goods are consigned to a private wharf owner), space on the wharf must be included where it *can* be so terminated, and *the carrier must become the wharfinger for the operation,* no matter what agency is employed to perform the physical work; this permits the Port Authority to withdraw to a prepared position whence it can execute its common-law warehousing duty free from ambiguity. The proposition is equally valid in the reverse direction, for it is only thus that the carrier can bring cargo forward in the proper order for stowing.

(23) This, in fact, is the usually accepted practice of working where a shipowner has ownership of his own terminal, or occupies a leased or appropriated berth but, in general, it is not feasible for a Port Authority to provide such a concession on any widespread scale since it leads to a wasteful use of a capital asset through under-employment of basic facilities provided. There are few trades indeed which require particular facilities which cannot be provided by "common-user" quayage. Contrapuntally to this, the growing demand for wharf facilities for inward and outward bulking of liquid commodities, i.e. latex and edible oils—a valuable and essential trade though relatively small in volume—effectively prevents wharves so equipped being employed on any but a common-user basis.

(24) The difficulty may be overcome by the licensing of shipowners as wharfingers during each specific loading or discharge operation, in such a way that the shipowner is granted a bare license to use the wharf and its appurtenances according to his reasonable needs, free of charge, until he shall have obtained his absolute discharge or until the Port Authority declares a closure. A suggested style of engagement is referred to in a later section.

(25) According to this scheme, the stevedore discharges the

vessel and places the goods at the effective disposal of the consignee (or his agent) at " point of rest " in the shed or in open-air storage adjoining, or, in the reverse operation of loading, he picks up the goods at outward point of rest where laid down conveniently by the consignor and stows them in the hold, always as the agent of the carrier while completing or initiating the contract of carriage. The seaward side of point of rest, for either direction of movement becomes, in effect, part and parcel of the ship and the operation of transfer is under the directive control of the carrier throughout.

(26) The range of the contract of carriage where cargo is transferred by lighter must be determined by other conventions based upon practical considerations not inconsistent with the principles discussed above. They are set forth in the section dealing with lighterage.

(27) The processes summarised in the previous paragraphs will be seen to avoid a dilemma often present in the ordering of the stevedoring operation: severing the contract of carriage at the vessel's side entails the appointment of separate stevedore organisations if legal responsibility is to be truly assigned, the one engaged solely for work on board and answerable to the carrier and the other working solely on shore and responsible as agent to the consignee. Yet speed and efficiency require that the cargo transfer should be conducted as a single unbroken operation under one directive control, properly exercised by the ship.

(28) This unity can, of course, be achieved if the Port Authority supplies the comprehensive service, either by its own stevedore contractors or by its own directly employed operatives, working under the direction of the ship's executive. In both cases charges will be according to the Authority's published Scale of Rates. Charges must be arbitrarily assigned between carrier and consignee. Frequently the Authority will be under a legal obligation to deliver cargo which may never have come into its custody. The carrier is allowed no choice of method in the performing of his own legal obligations under the contract of carriage. In applying for and accepting a berth the carrier must accept all the conditions in the By-laws of the Authority and the Scale of Rates attaching to it. If the ship is not satisfied with the manner in which its agent (the Authority) performs this monopolist service (as to method or cost) over which it has little or no direct control, it cannot change its agent and its only remedy is to abstain from using the wharves. The licensing of the shipowner as a wharfinger and the employment of a single stevedoring organisation removes all these difficulties.

(29) A further significant advantage will be secured in the simplification of delivery procedure by eliminating one tally and much of the documentary and accounting processes which at present duplicate work already performed by the shipowner in preparing the Bill of Lading. It should be possible to deliver the greater part of the merchandise direct to consignees *without any additional documentation or charges* provided the consignee takes delivery before closure is made. What cargo remains will be dealt with in the ordinary way by the Port Authority as the residuary wharfinger and charges assessed to the consignee can be looked upon as a natural penalty for delay in claiming his goods, without it being necessary to apply any other complicated sanctions. There is a clear inducement to the carrier to stow goods in a manner which will facilitate delivery with the minimum of sorting to marks. For example, block cargoes of homogeneous branded goods for delivery to many consignees, direct or by transhipment, might simply be port marked for the port of discharge or transhipment and delivered against leading marks affixed at the final destination. We are, in fact, a long step towards matching in the sea transport of goods the outstanding achievement of the postal service, which allows a correctly stamped letter dropped in a letter-box to be collected from a Post Office Box by the addressee on the other side of the world without any additional payment. The sole purpose of alongside berths is to provide opportunity for the handy assembly of cargo in Bill of Lading lots which can most readily be made available for delivery either to the cargo owner or to the ship. In the first case it is the carrier's duty and in the second it is in his best interest having regard to his contingent liability for correct delivery at the port of discharge. If this opportunity is not realised the capital outlay involved is largely wasted.

(30) Finally, the most important consideration of " public interest " is involved in the stevedore operation. How is freedom of choice to the carrier and protection of the *consumer* to be reconciled with the need for a consolidated stevedore contracting service and the formation of a Joint Industrial Council where realistic collective bargaining can be achieved? This aspect will be considered in later sections.

(To be continued)

Maritime Transportation Research

In May last, the Maritime Cargo Transportation Conference, National Academy of Sciences, National Research Council, Washington, U.S.A., held its third annual symposium. Most of the six papers read were in the nature of preliminary experimental investigations of a somewhat academic nature, but a paper by Mr. F. S. Macomber, entitled " Cargo Handling Savings Short of Full Containerisation " had a more practical approach and is reproduced below.

In the accelerating trend toward a radical solution of cargo handling by means of full containerships, the assumption is usually made that there is little chance of making any substantial progress in lowering the man-hours and elapsed time required to load a conventional cargo ship. The most common reason given for this assumption is that " the union just won't let us make changes. They have repeatedly blocked any reduction in the traditional gang size required for each hatch regardless of refinements in handling methods and equipment. Their economic power seems to be such that no break-through can be made except through the complete and dramatic revolution of the containership concept."

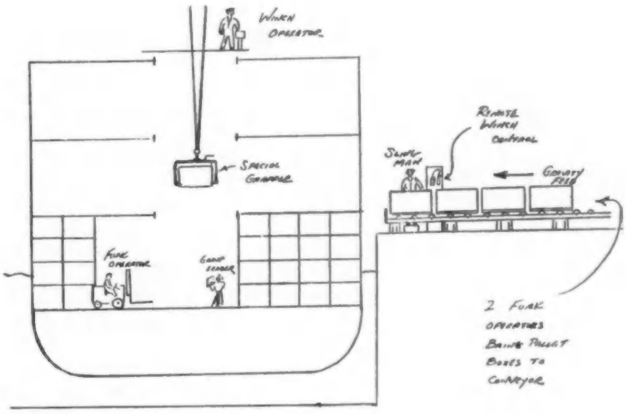


Fig. 1

It is our contention that this generally prevalent attitude, while based on realistic experience, has discouraged the application of modern materials handling and industrial engineering techniques to develop interim steps involving relatively minor modifications to conventional cargo ships that could reduce costs very substantially. To properly approach this problem, it is necessary to divorce the union situation completely from the physical cargo handling problem and take an entirely fresh look. It is the purpose of this paper to explore the magnitude of the savings possible through palletisation, using some concepts which may be new as applied to cargo handling.

In working out a more efficient method of loading a conventional cargo ship with minimum gang size, the various problems encountered were boiled down into the following:

1. Developing pallet box unit loads that were of "jumbo" size to utilise winch capacity effectively.
2. Developing variations in unit load height to fit the range of clearances available in various specific locations under the wings.
3. Developing gravity feeder conveyors placed at right angles to the ship to assure a constant supply of pallet loads to each hatch position regardless of the timing of the fork-lifts supplying such unit loads.
4. Minimising the manpower required to operate the winches and pallet grappling devices (see Fig. 1) by installing remote winch controls.
5. Avoiding any interference with a rhythmic unit load movement from a fixed position on the conveyor to the hatch square.
6. Overcoming differences in floor level at the hatch combings so that wheeled power vehicles may operate anywhere on each deck.
7. Squaring off the storage areas on each deck to segregate hand stow areas caused by the canted walls of the ship from rectangular areas suitable for palletised loading (see Fig. 2).
8. Painting the floors with specific pallet locations and working out a sequential loading pattern which shows which combinations of pallet heights are required to make best use of head room.

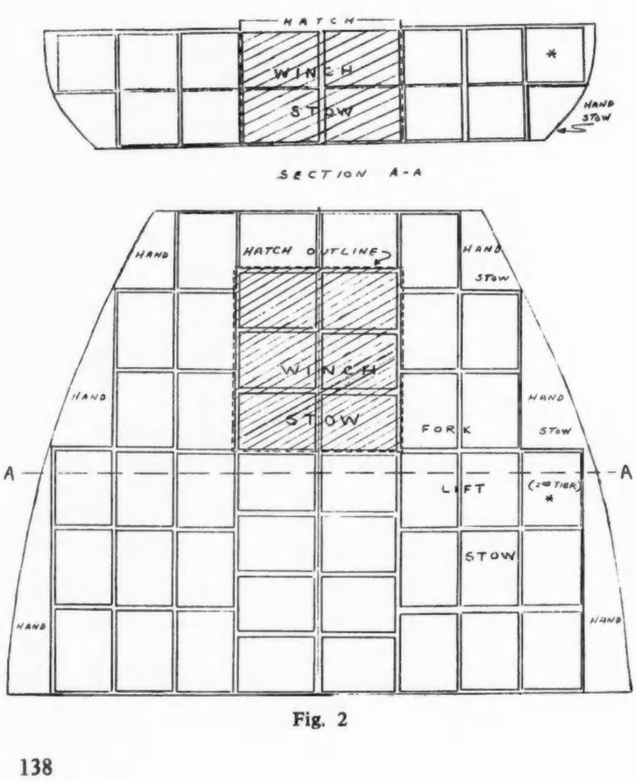


Fig. 2

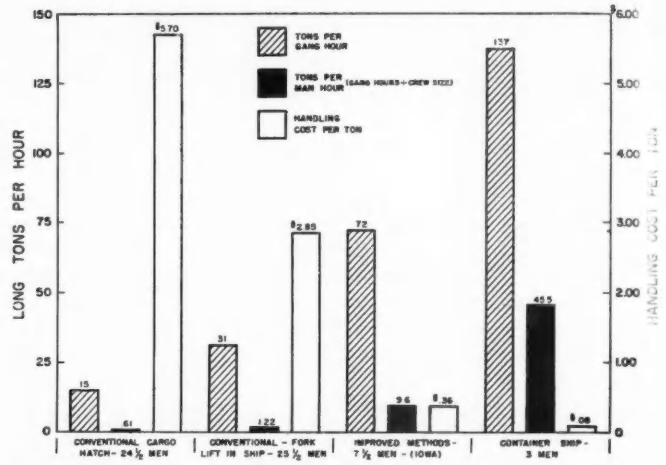


Fig. 3. Comparison of cargo loading productivity and costs—showing four stages in the evolution of handling methods.

By adapting existing material handling devices and techniques and using relatively large pallets (approximately 200 cubic feet) with sides to ensure dimensionally stable unit loads, the typical hatch crew can be reduced to the following if we "start over" without regard for past practices:

In the Hatch

1 Group leader who plans the loading, unlocks the grappling mechanism and is boss of the crew using telephone and direct communication.

1 Fork-lift operator who puts pallet loads away in positions as directed.

On Deck

1 Winch Operator.

Beside the Ship

1 Sling man who controls the lowering winch and attaches the grapple.

In the Shed

2 Fork-lift drivers who bring loaded pallet boxes to the conveyor.

Total 6 Men per hatch.

By adding relief men and a group of 5 extra men per ship that help in the hand stow portions of the loading when required, we end up with an average crew of 7½ men per hatch. By adhering to a rhythmic two-minute winch cycle with unit loads being placed in position by the fork-lift in the hold, a minimum of delay results. The proposed crew equipped with the more refined devices indicated can load at an average rate of 80 long tons an hour during the mechanical portion of the loading. Figuring delays in changing from one deck to another, closing hatch covers and filling out the hand stow portions of each deck, an over-all rate of 72 long tons per hour, or 9.6 tons per man-hour, is indicated. At an hourly rate per man of $3.47 this works out to approximately $0.36 per long ton for the loading operation. This may be compared to a comparable loading rate using a conventional stevedoring gang of $5.70 per long ton (see Fig. 3).

Although it is possible through the medium of full containerships to reduce this to an ultimate direct labour cost of approximately $0.08 per ton, the $0.36 cost represents 85% to 90% of the difference between the present featherbed cost and the ultimate potential through containerships. Thus with relatively minor modifications and the introduction of pallet boxes that are collapsible, conventional cargo ships could compete quite well with containerships provided the correct number of men may be used on an engineered basis using modern material handling practices.

The Use of Aerial Ropeways in Handling Ships' Cargo

By R. H. T. Mackenzie, M.I.C.E.

IN the year 1644 a Dutch Engineer in Danzig was faced with the problem of transporting a large quantity of earth across a valley for construction of a fort. Apparently, even in those leisurely days, speed of construction could be important and even reduction of manual labour was desirable. The engineer must have been ahead of his time for he realized the advantage of carrying the load over the valley on a stretched rope rather than by surface transport across the contours of the intervening land.

He therefore rigged an endless hemp rope spanning the valley, passing over pulleys suspended from posts and carrying loaded baskets on one side and empties on the other. Doubtless his labourers were duly grateful for this relief from muscular effort since the economic conditions of those days could hardly have resulted in any agitation on account of redundancy of labour due to introduction of "mechanical handling." There is no known record of later serious development of carriage of goods by ropeways prior to the invention of wire ropes some 200 years later when the first practical ropeway forming the basis for modern design, was constructed in the Harz mountains by a British Engineer, Charles Hodgson.

With the establishment of the feasibility of aerial ropeway transport, widespread adoption was conditioned by adaptations required for different purposes including such details as designs of carriers for different types of material, methods of filling and emptying them, their spacing on the rope and suitable methods of traversing the carriers along the ropeway alignment. The material to be carried for which these provisions had to be devised was for many years confined to bulk minerals and even now this is the type of material for which ropeways are most widely used. Working of mines, quarries and other mineral deposits and the disposal of ash from power stations are examples of such uses. For these purposes the design of bucket carriers employed depends on the type of material handled. Thus tipping buckets are used for dry easily flowing minerals and bottom opening buckets for sticky material. As the applications of ropeways have developed other types of carrier have been adopted suitable, for instance, for carrying timber, oil in drums, general merchandise and eventually passengers. The carrying capacity of carriers has increased and their spacing along the ropeway alignment decreased with developments in the strength of wire ropes. Various installations for operating ropeways have been adopted according to individual conditions including steam, electric motors and internal combustion engines.

Early in development a fundamental consideration arose. Should the carriers, as in the case of the Danzig prototype, be suspended from and fixed to an endless, continuously moving rope carried on pulleys mounted on trestles (the monocable) or should the carriers be hung from wheeled travelling carriages suspended below a fixed track rope with an endless haulage rope (the bicable) for imparting movement to them? Whilst the arguments for and against the two systems were contentious for many years it has now been largely agreed that each system has advantages when applied in suitable conditions of working. For cargo handling the bicable system is the more usually adopted.

With growing experience of the uses of ropeway installations it is not surprising that as early as the end of the 19th century attention was being paid to their use in the loading and unloading of ships' cargo, both in docks and off-shore anchorages. A vital part of the work of harbour authorities consists of the planning of programmes involving turn-round of ships, railway wagons or road trucks. Though such planning has become extremely accurate and to a great extent avoids such contingencies as wharves being occupied unnecessarily and congestion of wagons or trucks, provision has to be made for so many unforeseen circumstances that delays are bound to occur from time to time.

It will be noted that reference is being made to handling by "ropeway installation" and it is important to note that planning a loading project comprises in every case not only the ropeway but ancillary equipment including mechanical handling devices for charging the ropeway carriers and discharging them into ships' holds. In fact ropeway installation design involves high quality of skill and very considerable know-how which constitute a specialized branch of engineering in which British firms lead the way.

The mechanical handling devices require to be selected or specially designed in accordance with the requirements of each installation and certain of these will be referred to later in the description of individual schemes.

Before leaving the general question of the ropeway itself it will be useful to refer shortly to certain features which are common to all ropeways.

It is obvious that the alignment of a ropeway of any length cannot be expected to be in one straight line; changing of direction on plan must be provided for. These are effected by angle stations which normally comprise a built-up steel gantry on which are mounted shunt rails tangentially deviating from the straight lines of travel and tracing the line of the required curve. The carriers are transferred automatically from the carrying ropes on to these shunt rails on which they travel round the curve, to be automatically reconnected to the rope at the end of the curve and travel on to their destination. In the bicable type of ropeway the carriers are pulled round the curve by the endless haulage rope running against freely rotating pulleys. In the monocable ropeway the shunt rails are laid at a slight grade and the carriers travel round them by their own momentum. Such angle stations permit of the ropeway being aligned on the most economical and convenient line as regards ground contours, avoidance of obstacles and other similar considerations.

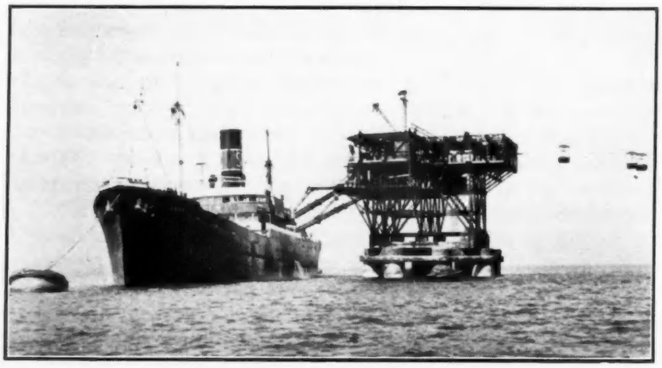
Similar arrangements of shunt rails are provided at both ends of the ropeway. At the loading station the carriers run on these rails to be temporarily stopped at the loading point such as, in the case of bulk mineral handling, a chute leading from a bunker. At the delivery station the carriers are discharged either after being brought to rest or whilst in motion and then travel round a return station, comprising a circular shunt rail track, and back to the loading station for recharging.

Iron-ore Handling in the English Channel

An interesting example of off-shore loading which, under great construction difficulties, solved the problem of developing valuable mineral resources, is the installation designed and built by Messrs. Applevage of Paris at Diélette on the west coast of the Cherbourg Peninsular.

The iron ore mines here were closed down in 1892 due to the

inadequacy of the port for sea-going vessels of more than 500 tons and the virtual impossibility of lighter handling due to weather conditions. In 1907 the Society of Mines and Quarries of Flamanville decided in view of the ever increasing demands for iron ore and the great extent of the deposit, to carry out intensive development. To meet the existing conditions a bicable ropeway installation was decided upon using pylons erected in the water



The iron ore loading ropeway at Diélette. A close up of the ship loading station and the twin loading chutes serving the two ropeways.

and a caisson, manufactured in Cherbourg and towed to site, for the ship loading station.

This is no place to describe in detail the epic of the construction difficulties which were met with but due to the persistence and the skill of the engineers and after a long cessation of work due to the First World War, all these were eventually overcome and in March 1930 the first cargo was loaded and the valuable iron ore deposits of Diélette became available.

The installation comprises three main sections—the shore station, the ropeway itself and the ship loading station. Considering the ropeway first; this is of particular interest because it comprises two parallel, independently operated bicables carried on opposite sides of four specially designed intermediate pylons between the shore and sea stations. This provides flexibility of operation since each ropeway carries 250 tons per hour and the two can be operated either singly or in parallel. Worked together the installation provides for loading a 6,000 ton ship in 12 hours. The length of the ropeway between the shore and sea stations is 660 metres and each bucket carries 1,200 kg with 200 buckets per hour travelling at about 9 feet per second.

The shore station and its mechanical handling equipment comprise two bunkers each about 90 feet in length which are filled with mined ore brought from the crushers by means of belt conveyors. On the face of this bunker are 12 chutes through which the ore is loaded into the ropeway buckets travelling on shunt rails. On leaving the rail and being transferred to the ropeway track rope the buckets pass over automatic weighing sections. A circuit of shunt rails is provided for each ropeway but arrangements are made so that each can be switched to serve one or other of the ropeways. In addition to delivery of iron ore provision has been made at the shore station to receive loads of coal from the ship for use in the mine Power Station. The bunker for this coal is built at the end of the iron ore bunkers and is served by a siding from the main rail circuit controlled by shunt rails.

The ship loading station is carried on a reinforced concrete caisson founded on the rocky sea bottom. It accommodates a return station round which the buckets travel, emptying their contents en route into telescopic chutes discharging direct into the ship's hold. On the station a grab crane is mounted for loading coal into empty buckets for return to the shore station.

Loading Bulk Chemicals in Cyprus

Another interesting off-shore loading installation is that designed and erected by British Ropeway Engineering Company for the Hellenic Co. of Chemical Products and Manures in Cyprus. This was installed to overcome expensive and unreliable lighter loading especially due to the severe weather conditions experienced during certain times of the year.

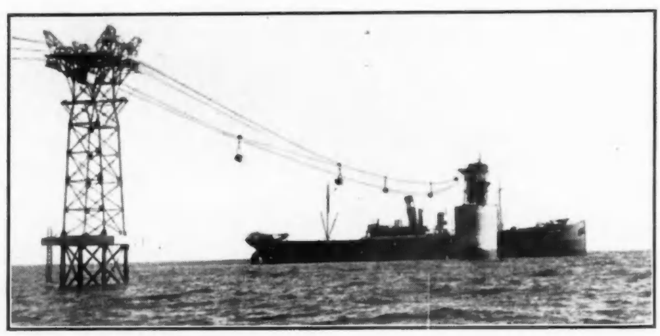
The installation handles 100 tons of pyrites per hour but is designed to carry eventually double this quantity by increasing the number of bucket carriers each of 27 cwt. The total length of the ropeway is 1,800 ft. and the speed of travel of the buckets is 274 ft. per minute.

The shore station comprises a storage area fed from a crushing and screening plant by means of a belt conveyor bridging the site and designed to dump its load at any selected point. The dumped material is formed into a stock-pile shored up by a wall by means of a drag scraper bucket which can be coupled to any one of a number of anchorages. Hand operated chutes in the stockpile wall discharge the material into ropeway buckets suspended from a shunt rail on which they then travel through an automatic weight recording station and on to the track rope of the ropeway.

This track rope is supported on three trestles erected in the sea and has its return station on the ship loading terminus which is a platform carried on a large concrete cylinder. The buckets automatically tip their load into a hopper which feeds the material through a hinged chute into the ship's hold.

To eliminate any chance of damage to the ropeway terminal due to the high winds experienced in the area, the vessels are moored independently to four permanent buoys. The hinged chute feeding the material to the ship's hold, controlled by a luffing winch, provides for adjustment according to the rise and fall of the ship due to varying loading whilst the chute can be slewed 60 degrees either side of the centre line to ensure accurate tipping into the hold.

The installation of this ropeway and ancillary equipment has made it possible to work the treatment plant independently of weather conditions to its full economic capacity.



Ropeway loading pyrites at Cyprus. The ship loading terminal and ship being loaded. Note the inverted empty buckets on the return trip.

Loading Magnetic Ore in Spain

The installation for loading 200 tons of magnetic ore per hour at Marbella in the province of Malaga in Spain was described in the April issue of this journal. No detailed reference to this is therefore called for here.

This installation has however one feature illustrating the importance of specialist design. In this case the installation comprises two ropeways—that for carrying ore from the mine to a storage dump close to the foreshore being a monocable of 50 tons capacity and that for delivering the ore from the storage dump to

the ship loading return station, a bicable of 200 tons per hour capacity. This ropeway is carried on trestles, two of which are erected on the land and two in the sea.

This is probably the only installation in the world comprising two ropeways of different types working in sequence and illustrates the expert knowledge which is required in ropeway installation design if full advantage is to be taken of the conditions controlling individual cases. Monocable ropeways are generally about 30 per cent. less expensive than bicables and so a considerable capital saving was effected by this design in which the monocable is engaged in forming the storage dump and the bicable takes over when the arrival of a ship necessitates the introduction of special loading and unloading arrangements which can be better applied to bicable ropeways.

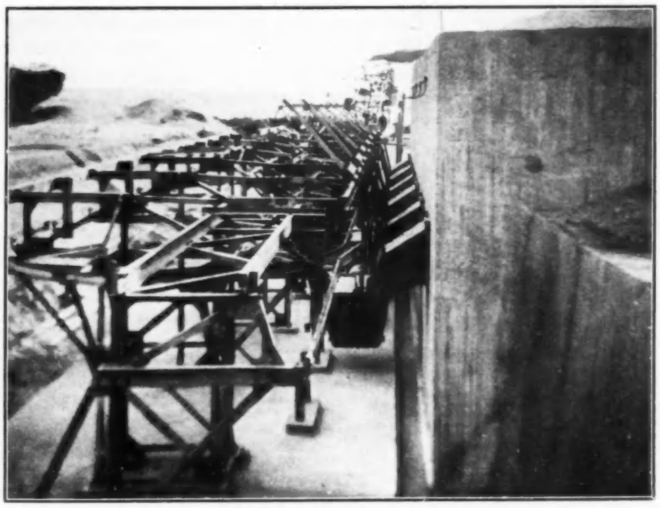
The design and construction of this installation was carried out by Ropeways Ltd of London with the concrete work by the Spanish firm of Dragados y Constructiones, S.A. The installation was put into service in October 1957.

Handling of Pumice in the Mediterranean

Owing to its light weight and cellular structure, crushed pumice is in considerable demand as an aggregate for manufacture of lightweight, thermally insulating concrete building blocks, cast in-situ concrete construction and other purposes. Pumice occurs in many parts of the world and a vast and useful deposit of high and consistent quality is found on the island of Yali in the Kyklades group in the Aegean Sea.

For the export of this valuable material from the small and isolated island the construction of a harbour was out of the question and in 1954 the concession-owning firm of Nomikos (London) Ltd decided to instal an off-shore ship loading ropeway. The scheme was designed in all its details by British Ropeway Engineering Co. and work was taken in hand in 1955.

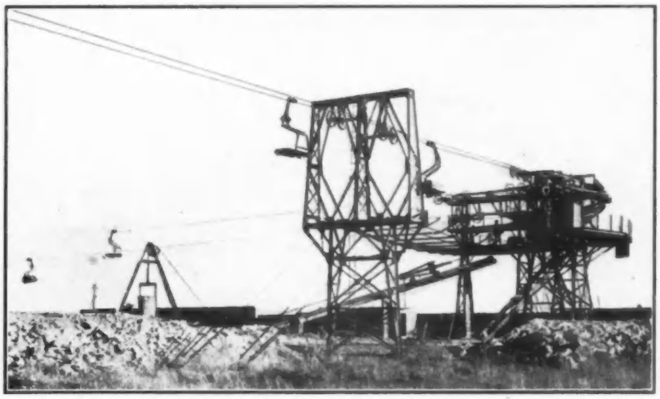
The installation as finally approved comprised a bicable system which has a designed capacity of 300 tons per hour but



Handling of pumice in the Island of Yali. Buckets travelling round the shunt rails at the land station being filled through chutes from the stock pile.

which to start with is equipped with a number of carriers necessary for carrying 200 tons per hour. As the output required increases it will only be necessary to increase the number of carriers, all other items of the design being adequate for the increased duty. The length of the ropeway is approximately 470 metres with four trestles on land and one in the water. The present number of tipping bucket carriers on the line at one time is 31, each carrying a net weight of 24½ cwts., travelling at a speed of 90 metres per minute. The driving power for the ropeway is provided by a 40 bhp electric motor.

The lump pumice quarried from the face of the cliff is lead to a crushing and screening plant from which products are drawn graded within the limits required. When ship loading is in progress these products are fed by a belt conveyor into a stock-pile from where it is lead by chutes mounted in the stock-pile



Loading cement in Western India. Loaded and unloaded tray carriers approaching and leaving the 91° angle station of the mono-cable ropeway.

retailing wall into the buckets of the ropeway which, in accordance with the usual practice already referred to, travel along below the chutes on shunt rails.

When no ship is awaiting loading or the ropeway is out of action, the screened products are carried by conveyor to an initial pile. The material in this pile is distributed along the stock-pile by means of equipment operated by an electrically driven winch. Six bucket loading chutes are provided in the retaining wall thus ensuring delivery of ample and continuous supplies when ship loading is in progress.

The installation is making possible the economical distribution of this valuable material to many countries throughout the world.

Loading Cement on the West Coast of India

An interesting plant of the Monocable type is installed in the works of Messrs. Shree Digvijay Cement Co. Ltd., Sikka (near Jamnagar) for loading bagged cement into sea-going barges. It was designed and erected by British Ropeway Engineering Company. The duty to be fulfilled is the carrying of a maximum of 60 tons per hour in 12 cwt unit loads from the packing station into barges moored at an existing platform erected in the sea—a total distance of about 4,000 yards of which a length of about 2,700 yards is carried on trestles erected in the sea. The lay-out provides a fall of 42 feet in favour of the load and ample power for all purposes in operating the plant is provided by an electric motor of 40 hp.

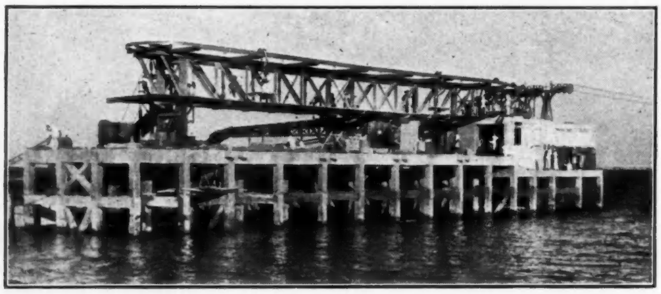
The factory terminal is situated at the packing plant and is carried on an elevated concrete platform accommodating the driving mechanism of the ropeway with the electric motor, control equipment and the loading station shunt rail.

Cement is packed in one-cwt. bags of the valve type. Normally jute bags are in use but consigments for outside India are packed in valved paper bags. The cement works have, in addition to two stationary hand-filling bagging machines, one stationary automatic and two rotary Fluxo packers. The rotary packers have a capacity of 60 tons per hour each and are connected by a series of rubber conveyor belts with the Ropeway terminal platform on which is situated the loading station. Discharge from any one of the rotary

packers can be led on to the loading platform where the bags are man-handled on to the tray carriers stationed on the shunt rail. As each carrier is loaded with 12 bags it is pushed manually along the shunt rail into automatic connection with the endless moving Monocable rope.

To make the tray loading operation continuous a special haulage gear has been provided whereby the carriers pass along the bay at creep speed enabling the bags to be loaded as the carriers pass.

The ropeway alignment comprises one angle station where the line takes a 91° bend. Further mechanical handling equipment is installed at the barge loading station which is installed on the sea platform alongside which the barges are moored. On arrival at this station the cement bag trays are automatically transferred from the moving rope to a shunt rail. As the trays come to rest the bags are off-loaded by hand and disposed of by two alternative methods. They are loaded on to a Four-ways slat type conveyor projecting from the platform which leads to a spiral chute down which the bags travel by gravity into the barge where they are packed into position by hand. In the alternative method, the bags are placed on a loading chute with a luffing jib down which they travel by gravity to the barge. By the use of these alternative mechanical handling devices, barge loading can be effected at all conditions of tide and of the available free-board of the barges.



Loading cement in Western India. A rear view of the barge loading station showing the shunt rails with unloaded tray carriers and, in the background, the Four-ways conveyor transferring bags to the barge.

This plant has been in operation for approximately the last three years and the following brief data represents the operational statistics for the year 1958:—

Total working during year	:	3,104 hours.
Average working per day	:	Little under 9 hours.
Total tonnage transported	:	129,280 tons.
Average tonnage per hour	:	41.65 tons.*
Maximum working on any day	:	18 hours 15 minutes.

* This represents the quantity of cement which requires to be despatched by sea going barges.

The operation of the plant has given complete satisfaction and shutting down due to break down or repairs has been negligible. Owing to the great increase in the use of cement in India, a project is now under consideration for large extensions of the cement works entailing possibly the doubling of the capacity of the ropeway.

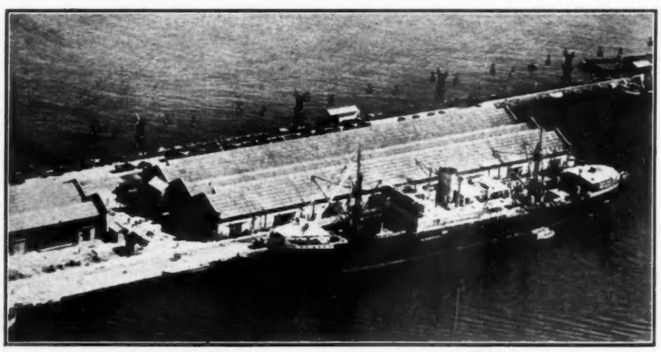
Bauxite Handling in East Africa

The original harbour of Takoradi on the Gold Coast, now the self-governing country of Ghana, was completed in 1928 and was constructed for the export of timber, palm kernels, diamonds, manganese and rubber. The imports were machinery, cement, tobacco, provisions, drugs and cotton manufactures. Timber exports were handled by means of a lighterage wharf but all other materials were dealt with through general merchandise wharves situated on the inner face of the straight Lee Breakwater which, with a curved Main Breakwater, forms the harbour enclosing some 200 acres of water.

The outbreak of World War II resulted in an enormous increase in the demand for aluminium and a method had to be devised for rapid construction of a means of exporting bauxite from the mines owned by The British Aluminium Company at Awaso, 150 miles from Takoradi. The main problem which arose was how to load the material on to ships lying at wharves on the Lee Breakwater without interfering with the existing import and export traffic. The design and construction of this vital installation was carried out by The British Ropeway Engineering Company.

This ship loading plant was based on the provision of rail sidings in the harbour, carried out by the Railway Authorities. These sidings gave access to the site of a stockpile on the foreshore some way from the Lee Breakwater. In addition, an extension of the then Gold Coast Railways from Dunkwa to Awaso, a distance of about 50 miles, was made to connect the mine area at Awaso to the Port of Takoradi. At the stockpile a wagon tippler was installed to deposit the ore which is formed into a shored up stockpile by means of a system of drag scrapers which were later supplemented by bulldozers. From the shored up face material is delivered by chutes into tipping buckets running on shunt rails from which they are transferred to the track rope of a Bicable ropeway, about 6,300 feet in length, carried on trestles erected on the foreshore and on the breakwater.

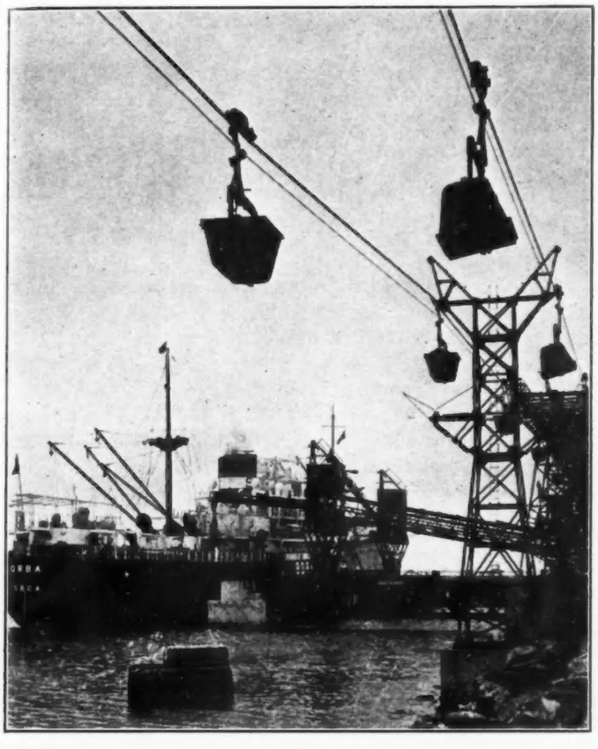
On approaching the ship-loading berth on the wharf, the buckets are transferred automatically from the track rope on to a shunt rail which runs parallel to the face of the bauxite wharf. By adjustable trip-levers the ore is tipped while the buckets are in motion into hoppers from which it is fed on to travelling transporters. The transporters consist essentially of conveyor belts mounted in wheeled frameworks running on rails carried on mass foundations whereby they can be positioned to suit the location of the holds of the ship. The belts carry the ore from the discharge hoppers outboard from the wharf to luffing chutes which discharge into the holds. The capacity of this ropeway is 300 tons per hour, using buckets of $31\frac{1}{4}$ cwt capacity travelling at 70 to 80 yards per minute and loading into ships the majority of which are of 6,000 tons.



Bauxite loading in Ghana. An aerial view showing that the ropeway does not interfere with surface traffic serving other wharves.

After the ropeway had been in operation for a considerable time the increase of traffic through the port involved major extensions including re-planning of the railway facilities. One item of this undertaking was the reclamation of land from the sea with material made available by the removal of what was known as Fort Hill. This involved the re-routing of the ropeway between

the stockpile and the shore end of the Lee Breakwater, as a result of which the first section of the ropeway was straightened and ran approximately level over the reclaimed land, thereby eliminating two angle stations and shortening the total length of the ropeway by about 730 feet. In addition, due to the provision of increased general merchandise wharfage accommodation on the inner face



Bauxite loading in Ghana. Buckets approaching and leaving the Bauxite wharf with travelling transporters discharging into the ship's holds.

of the Lee Breakwater, the bauxite berth was transferred from the inside harbour to the seaward side of the breakwater. This did not involve alteration to the ropeway trestles already in place along the breakwater

The rail wagons mentioned in the previous paragraphs are filled at the Awaso mine from a large bunker. A regenerative gravity ropeway about 7,650 ft. long carries the crushed and screened ore from the mine itself to a washing plant whence the final product is discharged into the above mentioned bunker by means of conveyors. This ropeway was installed in 1955 and superseded on economic grounds the previous system employing a fleet of lorries running on circuitous mountain roads.

Summing up the layout of the complete Takoradi installation it will be seen that, to provide a fully integrated scheme, a quantity of mechanical handling equipment was provided ancillary to the ropeways themselves. This provided for

(a) transference of the ore from the mine washery to the railway wagons,
(b) unloading the wagons at the dump site,
(c) scraping the dumped material to form a shored up stockpile,
(d) loading material from the stockpile into the ropeway buckets,
(e) discharge of the buckets through hoppers into the ships' holds.

The result—an automatic and continuous method of working entirely independently of the vagaries of climate at a transportation cost lower than by any other method.

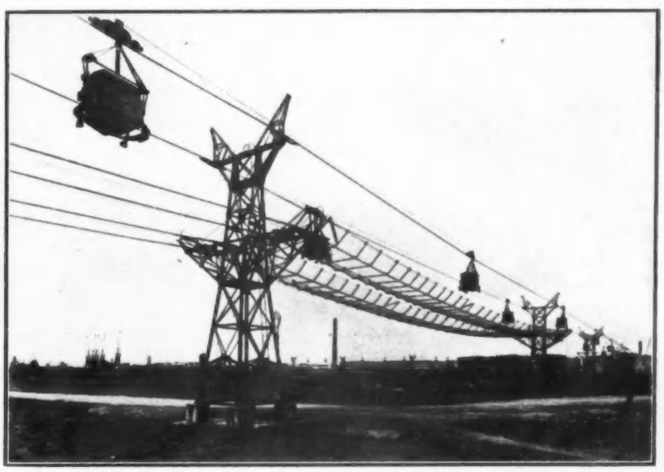
Handling of Chemical at Bristol

Mention must now be made of a ropeway designed for both loading and unloading ships. For this we turn to a ropeway installed by the National Smelting Company in the Avonmouth Docks for unloading zinc concentrate and, in smaller quantities, sulphate of ammonia and potash. These materials have to be unloaded from ships varying from 300 to 11,000 tons and delivered to their respective stores. The installation is designed to reload superphosphate after processing although for the time being, due solely to changes in sales policy, this reloading has been discontinued.

Unlike Takoradi the main problem here was not to avoid interference with the working of adjoining wharfs. In this case direct access was required to and from material stores by the shortest possible route over a number of railway sidings. Road surface transport would have involved a haul of about two miles over a number of controlled level crossings whereas the length of the ropeway is approximately 1,500 yards. When as sometimes occurs the ropeway is in use for one purpose and surface haulage has to be resorted to for handling some other material, it is estimated the transport cost involved is increased by up to 30 per cent.

Unloading of ships is by Port Authority electric grabbing cranes discharging into travelling hoppers running on rails. The bicable ropeway is mounted so that the buckets travel below the chutes from these hoppers being automatically stopped below the appropriate chute. In addition the whole operation of disconnecting the haulage rope, taking the tare weight of the buckets, filling them, taking the gross weight and reconnection of the haulage rope is entirely automatic.

The charged buckets—bottom opening to provide for handling sticky material—proceed along the ropeway, crossing a number of railway sidings over which protection nets are fitted. Buckets carrying phosphate are automatically brought to a halt opposite the phosphate store and discharged on to conveyors carrying the material into store. Alongside this store is one for processed



Handling chemicals at Bristol. Typical protection nets erected over railway crossings and roads.

superphosphate which, when required for export, is loaded into empty buckets by conveyors and is carried away to the wharf for discharge to ships' holds.

Buckets carrying zinc concentrate travel past the phosphate unloading point and discharge on to a conveyer connected with

a store for this material. Surplus supplies of zinc concentrate travel on to a dump from where it is distributed by a drag scraper and loaded into railway wagons for transport within the area of the works.

After installation had been in operation for many years major replanning to extend the dock became necessary. Though this was carried out at heavy cost it resulted in shortening of the ropeway alignment and elimination of two angle stations. That this expenditure was incurred is a measure of the success of the system which has been shown to be far more economical than any other.

The quantity of material handled varies between 200,000 and 250,000 tons per year. The type of cargo handled governs the handling rates since the quantities are 220 tons per hour for zinc concentrate and 170 for phosphate.

The maximum net load of the bucket—of which about one hundred are in use—is 34 cwt. These are controlled so as to be spaced about 37 feet apart and the speed of travel is 80 yards per minute.

Conclusions

These brief descriptions of some cargo handling installations are only an introduction to one application of Aerial Ropeway Transport—a rapidly developing industry involving mechanical, electrical and civil engineering. That this application is already well established is shown by the world wide interest being taken by dock and harbour authorities and by industrialists faced with ship loading and unloading problems.

Some of the proved advantages which have contributed to this interest include continuous operation irrespective of climatic conditions, low operating costs compared with other methods, independence of contours and conditions of approaches from the material source to the ship-loading point and eliminations of surface traffic congestion. Building up in congested dock areas of stocks for export awaiting loading and stocks for import awaiting removal must always be a problem to harbour authorities. And yet such build-up must occur if rapid turn-round of ships and delivery transport is to be achieved.

A dumping area outside the dock area for reception of both inward and outward bound cargoes which can be handled direct to and from ships' holds would go far to relieve such difficulties. Various ropeway carriers—some different types of which have been referred to—together with suitable means of loading and discharging them, would be required to make the system applicable to as wide a variety of cargoes as possible. These problems and many others are the subject of research by Ropeway engineers and with their experience and the success which has attended their previous efforts in solving earlier problems there is little doubt they will be overcome.

Evidence of the international importance which is attached to the development of the industry is provided by the appointment of a committee by the First International Congress of Funicular Transport at a meeting held in Rome early in 1957. This committee was for the purpose of formulating suggested international rules and recommendations concerning the design, construction, operation and maintenance of aerial ropeways—more especially in regard to safety of human life. It is proposed that the committee's suggestions will ultimately be forwarded to the Inland Transport Committee of the Economic Commission for Europe for international acceptance.

Other forms of transport—notably Maritime and Railway—are governed and controlled by internationally accepted standards and regulations. With the growing popularity of Aerial Ropeways it is vitally important that similar rules should be framed so that this young industry should start on the right foot. It is good to note that early steps are being taken in this direction.

Canadian National Harbours

More Cargo Handled during 1958

The 23rd annual report of the Canadian National Harbours Board, which was published recently, covered the operations for 1958 of the harbours of Halifax, Saint John, Chicoutimi, Quebec, Three Rivers, Montreal, Churchill and Vancouver, and the Government grain elevators at Prescott and Port Colborne. Although the number and tonnage of ships arriving at the harbours was less than the previous year, the aggregate cargo tonnage increased slightly, the increase in grain shipments being considerable. Operating income increased, but there was also a rise in expenditure.

The number of vessels arriving during the year (ocean-going, coastal and others) was 48,242, totalling 47,894,649 tons net, compared with 49,421, and 49,648,800 tons in 1957.

The aggregate cargo tonnage in 1958 was 47,083,689 tons, compared with 46,676,164 tons in 1957. This was an increase of 407,525 tons, or 1 per cent. Grain traffic increased from 10,456,471 tons to 13,217, 637 tons, an increase of 2,761,166 tons, or approximately 26 per cent. Other commodities with aggregate tonnages in excess of 200,000 tons, which had better figures, were bituminous coal, gypsum, lumber, logs, sand and gravel, motor vehicles and parts, wheat flour and raw sugar. Decreases were shown in fuel oil, crude petroleum, gasoline, pulpwood, newsprint, asbestos, wood-pulp and cement.

Foreign inward traffic increased by 7,877 tons to 10,498,256 tons, but outward traffic fell 413,421 tons, or 2.5 per cent, to 15,551,446 tons. Domestic traffic inward increased by 1,033,224 tons, or 8 per cent, while outward fell by 220,155 tons, or 3 per cent compared with 1957.

The following table shows the tonnages of foreign cargo handled at the various ports:

	('000 tons) 1958		1957	
	In	Out	In	Out
Halifax	3,279	2,097	3,262	2,111
Saint John	858	1,147	787	1,318
Chicoutimi	23	3	56	3
Quebec	166	847	90	814
Three Rivers ...	263	753	308	579
Montreal ...	4,853	4,327	4,585	4,136
Churchill ...	33	592	21	498
Vancouver ...	1,020	5,280	1,377	6,503

Operating income for the year amounted to $24,075,931, comwith $23,303,811 in 1957, an increase of $772,120. Expenses of administration, operation and maintenance were $14,786,764, as against $14,270,611, an increase of $516,153. The net operating income was $9,289,167, compared with $9,033,200, an increase of $255,967. After taking into account other income and deducting special charges, including interest on debt and reserve for replacement of capital assets, operations resulted in a net income of $1,072,208, compared with $1,325,102, a decrease of $252,894.

Major construction projects completed or in progress during the year included new or improved wharves at Halifax, Quebec, Three Rivers, Montreal and Vancouver; new transit sheds at Halifax, Quebec, Three Rivers and Montreal, and extensions to transit sheds at Saint John; additions and/or improvements to grain elevators, loading and unloading facilities, and equipment at Halifax, Saint John, Quebec, Montreal and Vancouver; expansion of the electrical system at Halifax, Quebec, Montreal and Vancouver ; new quick-freezing equipment in the cold storage warehouse at Montreal; installation of a cargo crane at Vancouver; and dredging at Montreal.

A Pattern of Sediment Transport for Sea Floors around Southern Britain

By A. H. STRIDE
(National Institute of Oceanography)

Introduction

A pattern of sediment transport has already been inferred from the shape of the sand waves on the floor of a southern part of the North Sea (1). The method rested on the observation that sand waves advanced in the direction faced by the steep side of the ridges. The same pattern of transport could be inferred from the set of the strongest tidal streams, since observations show this to be the cause of the preferred direction of advance (2, 3, 4). That conclusion was reasonable since the amount of sediment transported is a steeply increasing non-linear function of stream velocity and so the stronger streams will move a disproportionately large amount of material (see for example, 5). In the present paper the set of the strongest streams has been taken from **Atlas der Gezeitenströme für die Nordsee, den Kanal, und die Britischen Gewässer (Deutsches Hydrographisches Institute,** Hamburg, 1956), because the results are presented in a particularly suitable manner. It is assumed that the amount of sediment moved in the direction of the strongest tidal stream is everywhere in excess of that moved by the alternate oppositely-directed stream, and that these observations of surface streams are an indication also of the pattern of water movements to be found near the sea floor.

The speeds of the surface streams are more than enough to move sand. Their effect on the sea floor is evidenced by the morphology and by the presence of patches of sand elongated parallel to the path of the strongest streams (6). The same pattern has been found more recently, in the middle of the English Channel, and south of Eire. The absence of such features in a particular place is, of course, not necessarily an indication of lack of transport of sediment.

In the present paper both lines of evidence are used to infer the probable pattern of bed transport for seas around southern Britain, with the edge of the shelf as the natural western limit. Information is abundant for the North Sea but much less abundant for the English Channel and adjacent seas. Nevertheless even here there is satisfactory agreement between the two lines of evidence.

A Pattern for the North Sea

Van Veen first pointed out the large area occupied by sand waves in the southern part of the North Sea (4). This ground has been re-examined and the search reached almost as far north as the Scottish border (Fig. 1). The sounding lines were fixed at intervals of about ten miles by means of Decca Navigator equipment and errors in position should all be small enough to be ignored, on the scale of the figures used in this paper.

Sand waves were present on the courses shown by solid lines but were absent where these are dotted. The slopes on either side of a sand wave crest may be equal (" S " on Fig. 1) or markedly different in steepness. The real direction faced by the relatively steep slopes is shown by separate arrows in some places. The orientation of these crests was defined by asdic (7) or by a detailed sounding survey, as off the Dutch coast. On all the sounding lines only the apparent direction faced by these steep slopes is shown by the flat-backed arrowheads. The true direction can then be told approximately by inspection of sounding lines of different orientation, although these general directions have not been shown on Fig. 1, in order to avoid overcrowding.

The pattern of transport, inferred from the shape of the sand waves, is typified by sand streams moving in a preferred direction for distances certainly up to one hundred miles, and secondly by complex patterns generally associated geographically with large sand banks (Fig. 1).

On the western side of the North Sea scattered patches of sand waves show that there is a thin northerly stream moving north from East Anglia to Flamborough Head. Similar evidence suggests the presence of a 10-mile wide belt of sediment moving south as far as about 52° North. In the rest of the Southern Bight there is a southerly stream moving towards the Straits of Dover and a 60-mile wide stream moving northwards towards the central parts of the North Sea.

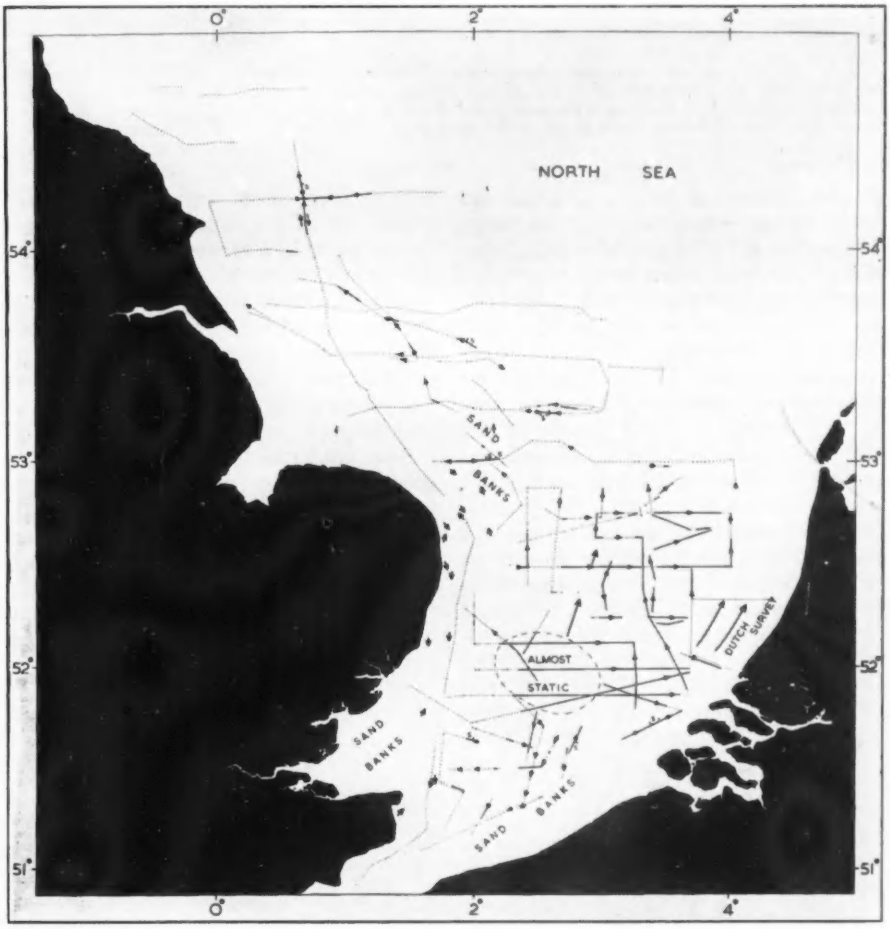


Fig. 1. Sand waves of the southern North Sea; present (solid line), absent (dotted line); direction of advance relative (—>—), true (—>); other lines (or with S) static ridges.

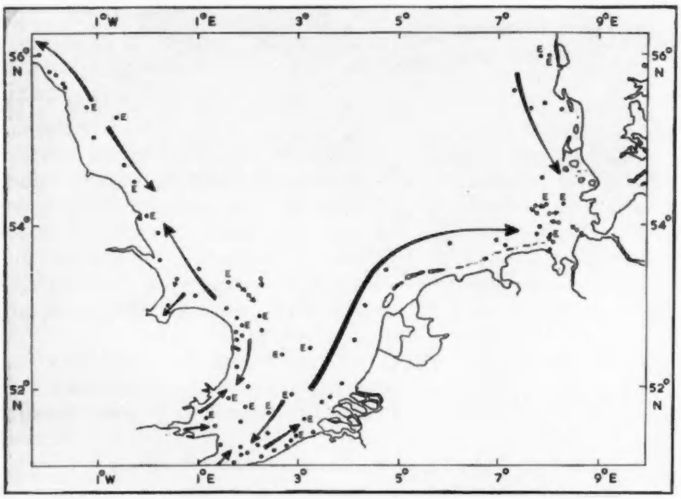


Fig. 2. Set of the usual strongest tidal streams in the southern part of the North Sea were available for points dotted. The general pattern is shown by large arrows with local deviations shown by small ones. Ebb and flood streams reach the same peak speeds at "E."

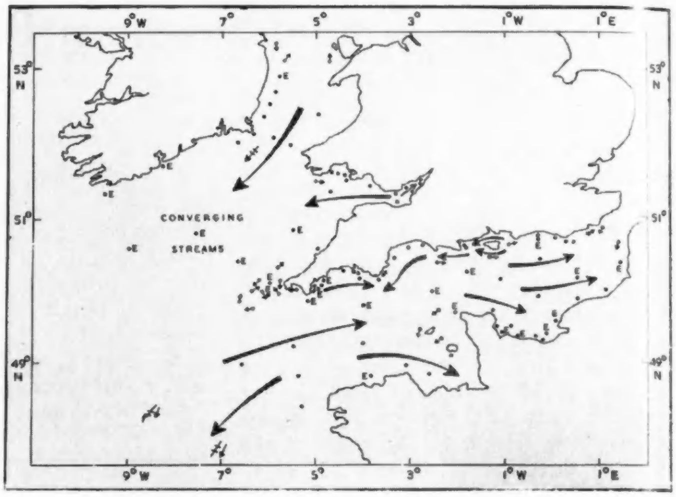


Fig. 3. Sand wave and tidal stream data for seas south and west of Britain. The latter were available for points dotted, with general direction indicated by large arrows and local deviations shown by small arrows and equal ebb and flood streams at "E." True direction of advance of sand waves shown by barbed arrows.

In the vicinity of 52°N., 02°30′E., the sand waves are virtually static. The limits of this region are only approximately determined since there must be a progressive change in profile towards the progressive sand waves on all sides, and because a lot of the records were taken on courses which were almost parallel to the crests of the sand waves and so give only a poor impression of their profile. The pattern of bed transport is probably as complex as is inferred for the channels between the big sand banks off the Norfolk coast. While most of the sand waves are static (not shown), there are local sand streams moving in opposite directions, even in the same channel. The same type of pattern is developed east of Flamborough Head, and is also recognisable near the Straits of Dover. The conflicting directions of transport indicated by a radioactive tracer (8) and inferred from sand wave profiles, in a channel near Great Yarmouth, is probably another indication of the same pattern. This and the distribution of banks in the southern North Sea have been interpreted in a like manner, as sites where the ebb or flood streams are dominantly developed (9, 10).

The second method of inferring the pattern of bed transport is to use the set of the usual strongest tidal streams, as suggested in the introduction. Observations were made at points shown by dots (Fig. 2) although these have had to be omitted from the Thames Approaches because of their abundance. Large arrows indicate the general pattern, while local deviations are shown by small arrows. Ebb and flood streams reach the same peak speeds at "E." Comparison of Figs. 1 and 2 shows a satisfactory correspondence between the inferred direction of advance of the sand waves and of the usual strongest streams, as was found in local studies. The velocity differences which are sufficient to drive the sand waves forward are generally about 0.2 knots for a stream reaching about 1 knot. The region of apparently static sand waves is associated with a region where the ebb and flood streams reach the same peak speeds.

The two patterns supplement each other geographically, to some extent. Thus, it can be seen that some of the sand streaming out of the southernmost part of the North Sea must be making for the German Bight, as it does near the coast (11), while another part is heading towards the Norfolk banks. Similarly, the currents from north and east should be moving sediment towards the Wash, behind which there has been extensive accumulation since the Pleistocene, although the relative importance of sediment supplied by rivers and by the sea is unfortunately not known.

The sand stream inferred to be moving north past the Lincolnshire and Yorkshire coasts probably ceases in the neighbourhood of Flamborough Head for here the peak speeds of ebb and flood streams are about equal. North of here the currents lead one to expect a sand stream running south and so leading to a convergence while north again the sediment streams should diverge. The prevalent pattern of sediment transport in the coastal portions of the southern half of the North Sea seems to be typified by such converging and diverging sediment streams; presumably leading to regions of deposition and erosion respectively.

There is a northward decrease in the grade of the sand on the floor off the Dutch coast (12) which it has been suggested is due to the selective removal of the fine grades of sand by the prevailing north-going stream. Although this effect cannot be demonstrated for the sediment streams off the east coast of England they probably play their part in the redistribution of the quite large amounts of material won from the coast each year. Little of the north-going sand stream has been trapped by the Silver Pit, for there is an outcrop of Chalk on its floor (53°41′N., 00°48′E.), but this is not necessarily an indication of the unimportance of that sediment stream.

Alterations of the Pattern

Echo-sounding lines of 28th and 29th March 1957 revealed that the steep slopes of sand waves around 52°35′N., 02°50′E., were facing S.E., approximately, and not northwards as found at all other times, although further east the usual north-going sand waves were found. Similar changes have been mentioned already by Van Veen (4), who considered that storms were responsible. The direction of net transport of water is certainly reversed at times (13) by winds of quite modest strength (14), and presumably this would also apply to the set of the strongest currents since the two set in the same direction in that region.

A Pattern for the Seas South and West of Britain

In the English and Bristol Channels the density of tidal-stream stations decreases towards the west and sand waves have only been found at isolated sites near the coasts and near to the edge of the continental shelf, so both lines of evidence are put to-

gether in Fig. 3. To avoid confusion on such a small figure, sites where sand waves do not occur have been omitted and a single arrow is used to show the set of the strongest streams common to nearby stations (dots). For the same reason it has been necessary to omit even some of the dots in the upper reaches of the Bristol Channel, around the Isle of Wight and amongst the Channel Isles.

It is inferred from both current and sand wave data that sediment should be moving south between the coasts of Eire and Wales, while the set of the strongest streams suggests that this should be joined by a west-going stream from the Bristol Channel, both heading towards a large region of accumulation between Eire and the north coast of Cornwall. The inferred pattern for the English Channel is more complicated; this is especially to be seen near to the south coast, where the sediment streams should be moving in opposite directions in adjacent bays such as Lyme Bay (3°W) and the wide, open bay (4.5°W) between the Lizard and Bolt Head.

The edge of the continental shelf is taken as the natural western limit of the floor known to be swept by tidal streams. It is fortunate that sand waves occur near to the edge for adequate observations of currents are lacking. A traverse across the sand waves near the Little Sole Bank (bottom left in Fig. 3) shows that adjacent parts of the floor must be swept by a dominant ebb or flood stream, with some sediment moving towards the deep sea. On La Chapelle Bank, nearby, the sand waves extend for 12 miles, the western slope of the last crest extending down smoothly into the continental slope. This relationship, together with the slight asymmetry of some crests, suggests that here, also, there may be an oceanward transport of sand off the shelf.

The inferred patterns of transport of bed materials are based on the best available data, but since this is incomplete and not enough is known about temporary alterations or of the rates, it seems wisest to consider the interpretations as tentative. Nevertheless, even in their present form the patterns should be near enough to the truth to show something of the complexity which can be expected in seas of the geological past.

It is hoped that this paper will do something to encourage further study of sea floors swept by tidal streams, which have been rather neglected because of the mantle of water and the greater visual appeal of related changes taking place at the edge of the sea itself.

Acknowledgments

This paper is based on records taken by a number of colleagues amongst whom special thanks must go to Dr. D. Cushing for the loan of most of the echo-sounding records for the North Sea. Messrs. M. J. Tucker and A. R. Stubbs generously took asdic records at the author's request, the Dutch Hydrographer kindly loaned detailed surveys showing sand waves off the Dutch coast and A. H. W. Robinson put his unpublished survey of the Skerries Shoal at the disposal of the author. Valuable criticism was offered by Dr. J. N. Carruthers and Mr. D. E. Cartwright, amongst others.

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Modern Propulsive and Steering Devices for Tugs*

The screw propeller with fixed blades mounted on a horizontal shaft is still the standard propulsive agent for most tugs and for river towing. In craft of this type, manoeuvrability and the ability to turn round in a small space are essential features. In this respect the conventional propeller and rudder equipment has certain disadvantages, and numerous efforts have been made by inventors, with varying degrees of success, to devise alternative methods of propulsion and steering that would provide a greater measure of versatility in manoeuvring.

Hydraulic Jet Propeller

One such attempt to improve the performance of tugs and other vessels in respect of manœuvrability is represented by the hydraulic jet propeller, of which the Gill propeller is a good example. Water is drawn in, by a pump, through an opening at the front of the vessel and is discharged in the form of a jet at the rear. The jet is capable of being deflected in various directions by means of an adjustable deflector plate pivoted about a vertical axis. The device is thus used for steering as well as for propulsion. The deflector can be swivelled through an angle of 180 degrees, so as to make the vessel go astern, if desired. The thrust developed by the jet can be modified by varying the speed of the pump, which is driven by an engine running at constant speed through appropriate gearing. A feature of this method of propulsion is that no part of the installation projects outside the hull of the vessel, and it is therefore advantageous in vessels that have to operate in very shallow waters. In other respects, however, it has not proved very successful.

Variable-Pitch Propeller

A different and more satisfactory solution is provided by the variable-pitch propeller. This device is equipped with adjustable blades whose pitch can be altered by rotation about an axis perpendicular to the propeller shaft, the hydraulic or other mechanism for effecting such adjustment being accommodated in the boss of the propeller. An ordinary propeller with fixed blades is designed for a comparatively limited range of operation (in respect of speed and load), and the available power of the engine is fully utilised only within this range. At higher and lower speeds of rotation of the propeller there is a decline in propulsive effort. On the other hand, with a variable-pitch propeller near-optimum conditions can in a great measure be achieved at all loads, i.e., in a sense it constitutes a whole range of optimum propellers. However, even a variable-pitch propeller can develop its full optimum performance only at the basic load for which it has been specifically designed. For any other load its performance is somewhat inferior to that of a fixed-blade propeller

*Based on three papers by A. Lederer, K. Helm and W. Moeckel, and P. Poismans respectively which were presented at the Third International Harbour Congress, held in Antwerp in June, 1958, under the auspices of the Royal Flemish Institution of Engineers.

designed for that particular load.

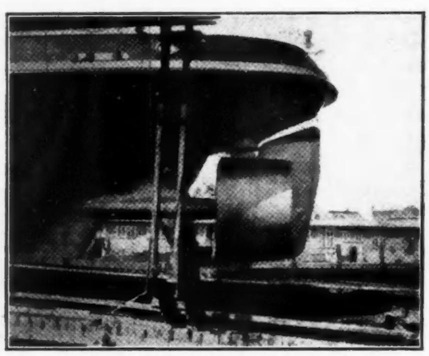
With the variable-pitch propeller all manoeuvres are performed by adjusting the blades. Thus, the vessel can be made to go astern without changing the speed or the direction of rotation of the engine. While propellers of this type offer considerable advantages, they also have certain disadvantages, not the least of which is their high cost in respect of initial outlay and in respect of maintenance. The boss of the propeller has to be a relatively large diameter, viz., about 0.35—0.4 D as against 0.2 D for an ordinary propeller (D being the overall diameter of the propeller). This represents a reduction in efficiency for a given propeller diameter. Another disadvantage of the variable-pitch propeller is that when the blades are set to zero pitch in order to check the vessel's headway, the steering action of the rudder is temporarily cancelled, and the vessel is virtually out of control.

Diesel-Electric Drive

An alternative to the variable-pitch propeller is to vary the speed of a fixed-bladed propeller by means of stepped reduction gearing or by the provision of a diesel-electric drive. In the latter type of installation the speed of the electric propulsion motor can be smoothly and swiftly controlled to suit any particular condition of load. Like the variable-pitch propeller, diesel-electric drive offers the advantage that the manoeuvres of the vessel can be finely adjusted and be affected more quickly than with the conventional type of propulsion and steering equipment. The engine need not be reversed and is thus less subject to mechanical wear.

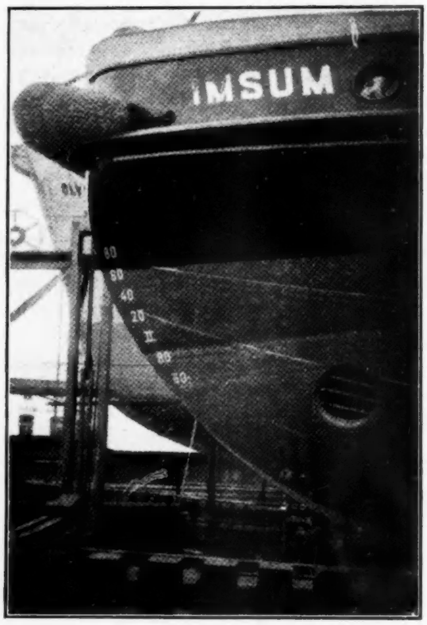
The Pleuger Rudder

In the case of a vessel with conventional steering gear the rudder is virtually ineffec-



Swivelling Kort tube.

tive when the vessel is going astern. The majority of present-day solutions for improving the manoeuvrability, and especially the astern manoeuvrability, of tugs and other vessels for use in ports, are based on the principle of changing the direction of the thrust developed by the propeller. Ordinary propellers capable of being swivelled horizontally are not very suitable, however, because once the turning movement of the vessel has been initiated, it is difficult to stop. An improvement is provided by the Pleuger rudder, a German invention which is being increasingly applied to harbour tugs. In its present form this device comprises a small auxiliary propeller



Bow of a harbour tug showing transverse-jet outlet.

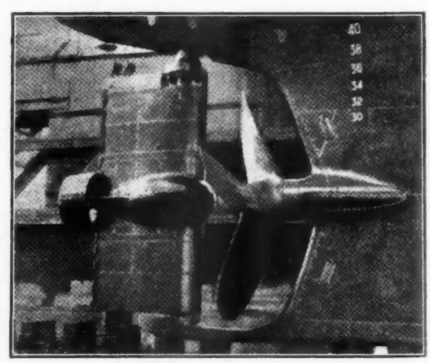
mounted on the rudder itself and driven by a submerged motor in a streamlined housing integral with the rudder plate. In addition there is a normal propeller constituting the main propulsive agent. The auxiliary propeller is swung from side to side with the rudder and can be placed at right angles to the longitudinal axis of the vessel, whereby good manœuvrability is obtained, permitting the vessel to be turned round almost "on the spot", i.e., without forward motion.

Transverse-Jet Propulsion

The desire to provide a forward-mounted device to assist a vessel in effecting a complete round turn rapidly and in the minimum amount of space has led to the development of several varieties of transverse-jet propulsion, inter alia, by the German engineering firms of Pleuger, Jastram and Knief. The object of these devices is to supply an additional transverse steering thrust, the bow is steered direct. The vessel is furthermore fitted with an ordinary rudder at the stern, or, alternatively, the device may be combined with the Pleuger rudder or the swivelling Kort tube (which is described below). In its present form the transverse-jet steering system consists essentially of a straight or slightly curved duct, or tunnel, placed athwartships at the bow of the vessel and containing one or two reversible propellers. The steering effect is greatest when the vessel is moving slowly, and diminishes almost to zero at high speeds.

The Kort Tube

The efficiency of an ordinary screw propeller can be considerably improved by mounting it in a special tube—with a hydrodynamically streamlined internal shape, bell-mouthed in front and slightly tapered towards the rear—which is rigidly attached to the hull of the vessel. This device is called the Kort tube, after its inventor. The water entering the enlarged front end of the tube is accelerated on its way through and is dispelled from the rear. The suction effect produced (which in the case of an ordinary propeller is detrimental to the propulsive action) is added to the thrust exerted by the propeller. A further development of this idea, aimed at achieving improved manœuvrability, consists in mounting the propeller in a pivoted Kort tube. The position of the propeller remains fixed, but by swivelling the tube in the horizontal plane the direction of the thrust can be varied, thus providing a steering action which is a combination of normal rudder action (which is enhanced by fitting the rear end of the Kort tube with a suitable fin) and deflection of the jet in different directions. One important advantage of this device, which is being installed to an increasingly large extent in tugs and other small craft used in German ports, is that a vessel equipped with it can be



Pleuger rudder.

properly manœuvred even while moving astern and can, under these circumstances, be made to turn in either direction. A vessel having an ordinary propeller and rudder can, when going astern, turn only in one direction, determined by the direction (left-handed or right-handed) of the blades of the propeller, while the rudder is vir-

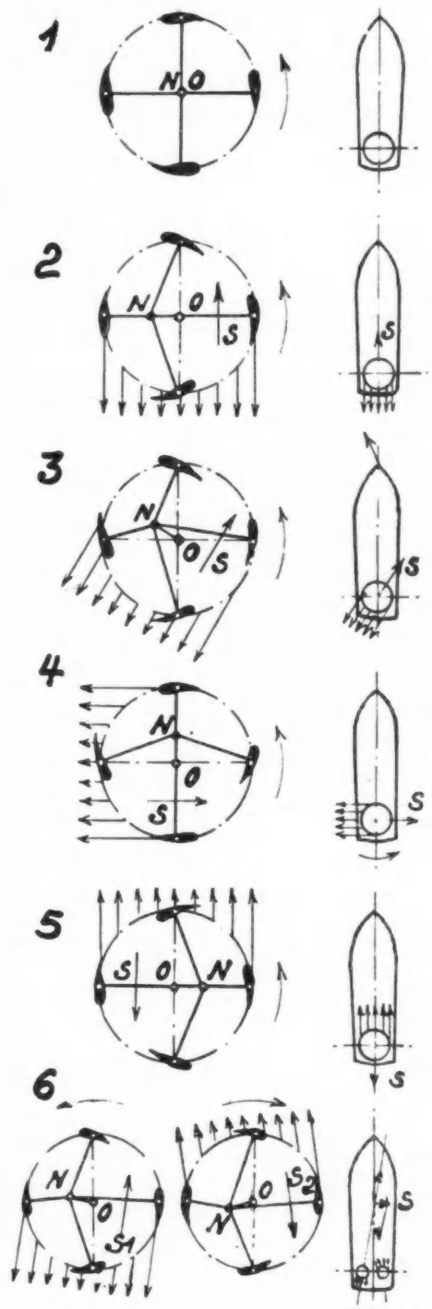
tually ineffective. In some tugs the swivelling Kort tube is employed in combination with the variable-pitch propeller.

Voith-Schneider Propeller

Finally, a description must be given of an important modern propulsive agent of an entirely different type, offering considerable advantages in cases where manœuvrability is a major consideration. This is the Voith-Schneider propeller, which is characterised by the fact that it consists of four, five or six vertical blades arranged on a circular periphery and revolving round a vertical shaft. Each blade performs an oscillatory motion (at a rate of one oscillation per revolution of the propeller) about its vertical axis, so that the "active" face of the blade is at all times kept perpendicular to the line connecting the axis of the blade with the point N (see the accompanying diagram), which is called the "control point". For any given condition of operation, all the blades of the propeller have one and the same point N. The important feature of this type of propeller is that by modifying the position of the blades, it is possible not only to displace N at will along the line ON (O being the position of the driving shaft at the centre of the propeller), but the direction of this line itself can be varied, so that N can at any time be given any desired position within the circular periphery of the propeller. The thrust developed by the propeller is always at right angles to ON and can thus be made to act in any direction, so that the propeller also serves for steering and manœuvring the vessel.

The captain of the vessel with Voith-Schneider propulsion has direct control over the speed and direction of motion of his vessel, the displacement of N being effected by means of servo-motors mounted over the propeller and operated from the bridge by the manipulation of a few simple levers or push-buttons. The controls are interlinking, thus ensuring foolproof operation. The mechanical layout of the Voith-Schneider equipment is lighter and more compact than that of conventional propulsive and steering agents, so that the engine driving it, run at constant speed, irrespective of the direction and magnitude (from zero to maximum) of the thrust, which are varied by altering the position of the blades. A high steering efficiency is achieved even at very low speeds of the vessel (a vessel equipped with ordinary steering gear must have a certain forward speed for the rudder to be effective). The maximum thrust of the propeller can be developed in any desired direction, enabling the vessel to be turned round practically "on the spot". A vessel equipped with Voith-Schneider propellers, installed on either side of the longtitudinal axis, can even be made to "transverse", i.e., to move at right angles to that axis. A further advantage of Voith-Schneider propulsion is that the vessel can be stopped very quickly and within a very short distance. In this respect, to, it is greatly superior to the conventional propeller.

Normally the Voith-Schneider propeller



(or pair of propellers) is installed under the stern of the vessel. For harbour tugs having to operate in confined spaces, however, it has been found advantageous to place the propeller(s) under the hull at approximately the forward middle-third point of the vessel's length. A tug of this type is known as a "water tractor". When such a tug is engaged in turning a large ship and takes up an oblique position in relation to the towing rope, there is no heeling moment (which does occur with an ordinary tug) and thence no danger of capsizing on the part of the tug.

As a typical example of harbour tugs with Voith-Schneider propulsion, mention may be made of two tugs constructed for use in the port of Antwerp. These vessels each have an overall length of 26 m, a width of 7.20 m, a maximum draught of 3.25 m, and a displacement of 185 tons. Each tug is powered by two 500 hp diesel engines driving twin forward-mounted Voith-Schneider propellers capable of developing a tractive force of 10 tons at the towing rope. The propellers are protected by an aerofoil-shaped screen 3 m long and 5.50 m wide. Each propeller is 2 m in diameter and is equipped with five blades 1.25 m in length.

Improvements at the Port of Haifa

The Haifa Port Authority have recently concluded negotiations on a scheme to enlarge the harbour facilities. The main quay is to be extended westward for 528 metres, thus providing additional deepwater berthing accommodation for two large vessels or three smaller ships. It is expected that the entire scheme will be completed in two years. The work, which is estimated to cost Israeli £7 million will be carried out by the Société Dunkerquoise d'Entreprises and the Tel-Aviv contracting company of Gut-Arpad, and when completed, will increase the port's capacity for handling dry cargo by ½ million tons a year. Heavy equipment, including two dredgers and a floating pipeline, will be employed by the Société Dunkerquoise in deepening the harbour alongside the new berths.

Pressure has for some time past been steadily mounting on the port's present facilities and, during the peak season in the winter, ships have been kept waiting for their turn at the berths. In the period January/June this year, the export tonnage handled was 40 per cent higher than in the same period in 1958, and passenger and cargo traffic has also increased. The Israeli merchant fleet, for which Haifa is the home port, is also steadily growing, making greater demands on berthing space, equipment and storage facilities.

The Ministerial Economic Committee of Israel has approved a draft contract with the "De Schelde" shipyard company of Flushing, Holland, for the construction of a shipyard at Haifa. In the first phase of the project, to be completed by 1962, the yard would undertake all repairs and maintenance of the Israeli merchant fleet and be capable of constructing ships of up to 8,000 tons.

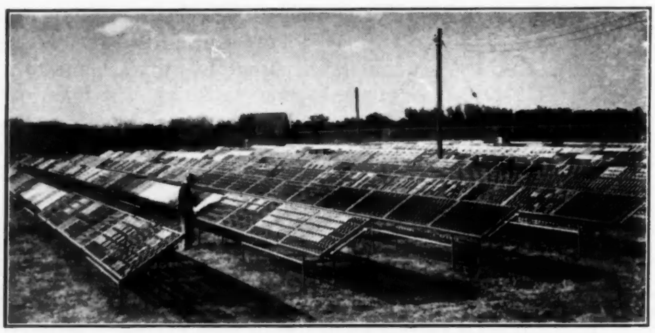
Corrosion Testing Stations in the U.S.A.

Research Work at Kure Beach and Harbor Island

The International Nickel Company runs the world's most extensive corrosion research stations at two sites near Wilmington, North Carolina, U.S.A. At Kure Beach materials are exposed to marine atmospheric conditions at Harbor Island, the nerve centre of the research operations, materials are tested by submersion in sea water. Collectively these facilities are known informally to industry as the Sea Horse Institute.

The tests are designed to increase knowledge of the relative resistance of materials to deterioration under many types of marine conditions. This knowledge is of value not only to Inco, but to a wide variety of producers and users of materials for application in or near the sea.

Sea water tests were first started at Kure Beach, in 1935, in the channel through which sea water was pumped from the Atlantic into the bromine plant of the Ethyl-Dow Chemical Company. When the chemical plant closed in 1945, the test beds were moved into the basin that had been used as the intake for pumps supplying water to the plant. Storm damage at Kure Beach in 1950 forced the abandonment of this site and new facilities for underwater tests were provided at Harbor Island.

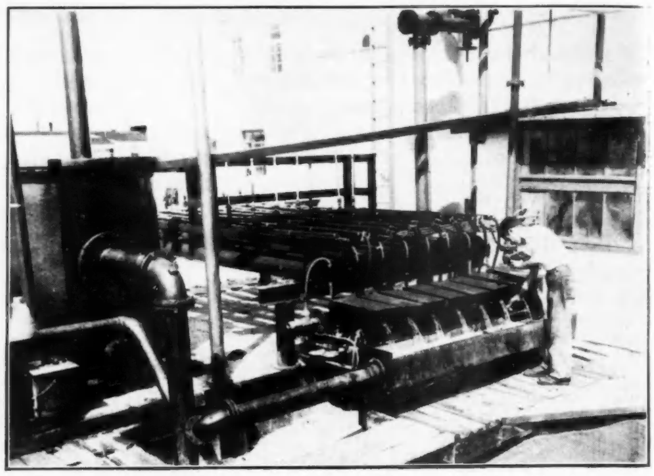


Close-up view of Inland Atmospheric Testing Lot at Kure Beach. Most specimens are exposed in the form of test specimens 6-in. by 4-in. by $\frac{1}{8}$-in. and mounted at an angle of 30 degrees.

Atmospheric corrosion tests covering over an acre of ground are still located at Kure Beach, as is a station about 80-ft. from the shoreline for testing the effects of sea water spray. The atmospheric tests lot, situated about 800-ft. from the shore, has room for the testing of 28,000 specimens.

The Harbor Island station is made up of a laboratory building which provides over 5,000 square feet of indoor testing and study space, offices, conference rooms, record files and maintenance equipment, and the racks and other equipment for sea water exposure studies. There is a marine museum where sample specimens are displayed and complete facilities for the provision of a photographic record of the many tests undertaken each year.

The wide natural channel at Harbor Island through which sea water flows back and forth with the change of the tide, forms an even better "Ocean Test Tube" than the basin at Kure Beach which was first given that name. There is a continuous supply of full-strength sea water uncontaminated by industrial wastes, oil films or other pollution that interferes with tests in harbours or near big cities. Sea water temperature at Harbor Island has a relatively wide range—from 45 to 85°F.—and there is a long season of growth of a large number of marine organisms, particularly valuable in the study of anti-fouling alloys and coatings.



Cast piping under test at Harbor Island Sea water flow is continuous and is controlled and maintained at pre-determined flow rates by means of valves (which are also under test) and orifice flow meters.

In the sea water tests, most of the specimens are exposed on racks continuously immersed at a depth of from 3 to 4-ft. It is possible to hang specimens from a large pontoon float when it is necessary to maintain a constant water line or a constant immersion in spite of the rise and fall of the tide.

The sea water racks themselves, with the exception of those furnished by individual co-operating companies, are made either of Monel, or of an alloy which contains 70 per cent. nickel. Some of these racks and rods have been in continuous use since 1935 and appear still to be as serviceable as ever.

Specimens are fastened to the racks with Monel machine screws. Galvanic effects are prevented by the use of bakelite insulating tubes over the bolt shanks and insulating washers between the specimens and the rack and Monel washers under the bolt heads. In another design of rack the specimens are held in grooves in porcelain insulators fastened to Monel racks by Monel fastenings. Some of the original Monel screws and nuts are still in use and in excellent condition after 23 years.

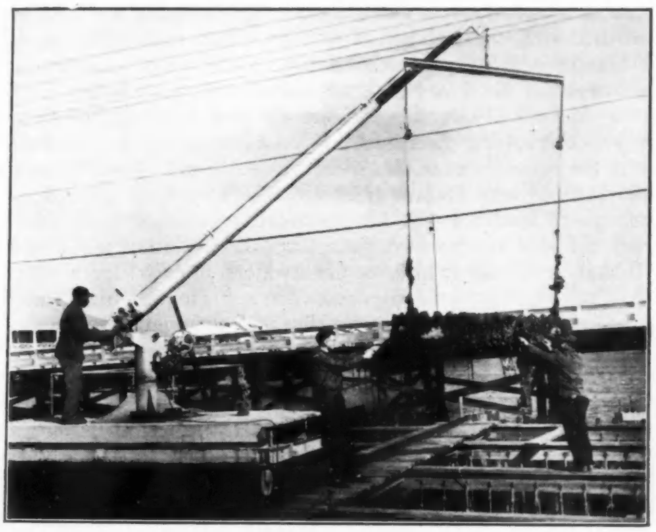
The period of exposure of specimens may vary from a few days to as much as twenty years.

View of wharf at Harbor Island. The wharf is used to support racks on which specimens are mounted for continuous and intermittent immersion in sea water. It is also employed as a platform for testing actual equipment such as evaporators, pumps, piping and valves.

Each pile in the rack-supporting structure serves as a test piece. In addition to timber piles, treated with different preservatives against marine borers, the steel piles being used have been given several types of protection against corrosion. These range from modern organic coatings, through hot-dipped and sprayed metallic coatings, to Monel and cupro-nickel sheathings which are applied to the critical tidal zones by different means, from integral cladding to welded or mechanically fastened wrappings. In addition, many piles are given a cathodic protection through current generated by magnesium anodes as a supplement to the other means of protection employed.

The need for more precise information on the abilities of alloys to withstand the severe erosive of wearing effects associated with such uses as condenser tubes, piping systems, propellers and other underwater parts of fast-moving ships has led to the design and operation of several types of erosion-testing apparatus.

Many of the materials under test also serve practical purposes. The roof of the laboratory building, for example, is of welded Monel roofing sheet. The fence around the laboratory is in two sections—one of 18/8 chromium nickel stainless steel and the other of galvanised steel. Several metals have been used for salt water pipe lines, including 70/30 cupro-nickel, Monel and Ni-Resist cast iron.



Specimen rack being withdrawn by mobile crane for examination on wharf at Harbor Island.

At Kure Beach the effects of atmospheric corrosion are measured by visual observation and by determination of weight loss, changes in mechanical properties, or both. The test frames, with their insulators, may be made to accommodate several types and sizes of specimens.

New specimens of certain key materials are put on the racks each time a large group is removed, or a new group is installed. These key specimens provide information on changes in the corrosive nature of the atmosphere itself from year to year, thus assisting the interpretation of the results of tests made over different time periods. The close proximity of the sea spray racks to the surf breaking on the adjacent beach makes the corrosive conditions comprising spray and sea air very severe. Some steels are corroded ten times faster here than in the atmospheric lot further from the ocean.

One distinguishing feature of the research project at Kure Beach and Harbor Island is the way in which producers of sometimes competitive products have united in the fight against the common enemy—corrosion. The discussions of corrosion problems at the periodic conferences of the Sea Horse Institute, organised by Inco, have proved to be one of the research and testing station's most valuable activities. Information built up over the years continues to be exchanged freely and made available to industry as a whole as well as to the government agencies for whom and with whose co-operation much of the research has been undertaken.

Book Reviews

Elements of Cargo Handling by Col. R. B. Oram, O.B.E., E.R.D. Published by Sir Isaac Pitman and Sons, Ltd., Parker Street, London. Price 12s. 6d. net.

Cargo Handling is a subject on which very few books of reference have so far been published, although few activities have a more direct bearing on the cost of living in a maritime country. In view of this, " Elements of Cargo Handling," which deals with the principles and practice of the subject, will be particularly welcomed. Its author is well qualified; he has spent many years in the service of the Port of London Authority; from 1951-56 he was superintendent of the Surrey Commercial Docks; and he is, at present, Port Consultant to the International Cargo Handling Co-ordination Association. His aim has been to present the subject in broad terms which any practical officer can adapt to local circumstances. Many useful diagrams are provided and there is a glossary of technical terms.

The book analyses the handling of cargo from the export shed via the ship to the discharging port and contains a most interesting chapter on labour arrangements, which should prove of considerable value in view of the recurring disputes on the docks.

This book is intended to be read by the staffs of dock undertakings, shipping companies, forwarding agents, and those bodies whose work revolves around the loading and discharge of ships but where few opportunities exist for daily contact with the docks. It will also prove useful to students of the Institute of Transport and the City and Guilds of London Institute.

The Port of New York by Dr. John I. Griffin. Published by Arco Publishing Co. Inc., 480 Lexington Avenue, New York, 160 pp., cloth bound. Price $5.

This book is the result of data developed by the Institute of New York Area Studies of the City College of New York while working under a Rockefeller Foundation research grant. This grant made possible the establishment of a programme of graduate instruction in which the products of research could be utilized as resource materials in seminar and classrooms.

Dr. Griffin, a member of the Research Institute and a professor in the Bernard M. Baruch School of Business of the City College, has produced one of the most significant volumes ever written on the development and economic importance of the Port of New York, treating the port for the first time as a functional unit. Inter alia, he deals in detail with the vexed question of ownership—should it be state, city, bi-state, or private.

With the aid of his colleagues in the Institute, Dr. Griffin has thoroughly covered the complete facilities and activities of the port, its administration, waterfront labour problems, transportation services and rates, and predictions as to the future of the Port. The net result is a book that will prove of value to the shipper, traffic manager, exporter and importer, or anyone who uses this great port's various facilities.

Fully indexed, the book contains a selected bibliography and appendices listing private steamship piers, city-owned piers, and the Port Compact of 1921. There is also a flap insert in the back of the book containing a full colour map of the Port of New York, showing the locations of all city-owned facilities.

Dock and Harbour Engineering. Vol. 2: The Design of Harbours, by H. F. Cornick, M.C., M.I.C.E. (Charles Griffin and Co. Ltd., London.) Price £6 6s.

This recently published volume is the second of the above treatise, the first volume entitled "The Design of Docks" being published last year and reviewed in the June 1958 issue of this journal. The third and fourth volumes named respectively "Buildings and Equipment" and "Dock and Harbour Construction," are in active preparation. W. P. Shepherd Barron (formerly Chief Engineer of the Port of London Authority and Past President of the Institution of Civil Engineers) contributes the Foreword.

The principal aim of the treatise as a whole has been to assist the student and engineer in their study and research in dock and harbour engineering, operation and construction, by collecting in it authoritative data and examples, selected from the Proceedings of learned societies, technical journals, other printed works devoted to the subject, and from the Author's own experience with the Port of London Authority and elsewhere. A full list of references and bibliographies is also provided to facilitate further studies. The result is a work of almost encyclopaedic proportions set out in evolutionary sequence of development from earlier works to the present day. This makes for interesting reading and should make possible a better appreciation of the merits of recent techniques and the gradations through which progress has evolved. A good feature is the descriptions of ground and site conditions of maritime works selected for discussion and while it is true that certain recent plant improvements and construction methods have, to some extent influenced design, most of the examples chosen form good object lessons, from which are readily apparent the reasons why the types of construction in relation to the facilities available were adopted.

It would be remarkable if no criticism could be made in a work of this magnitude. It might perhaps have been better to have dealt with the important subjects of Geology and Soil Mechanics in volume 1, followed there by the Design of Docks Walls and Graving Docks. In this position it would also have been a prelude to the Design of Breakwaters and Jetties. The author has however preferred to do so in volume 4, which is devoted to Docks and Harbour Construction. A disadvantage inherent in most scientific treatises of any magnitude, is the lapse of time between writing the first chapters and their publication. In this present volume, however, it is noted that it is proposed to deal, in volume 4, with some very recent developments in dock walls and graving dock construction which are only mentioned in volumes 1 and 2.

Chapter 7, which is the first chapter of Vol. 2, is introductory. The general principles of Harbour Design and a critical examination of the factors to be considered are discussed in Chapter 8. In particular the nature and effects of natural phenomena such as wind, wave action, seiche, tidal and river currents, littoral drift, coastal accretion and erosion are examined at length. Methods of solution of such problems by means of breakwaters, revetments, groynes, training walls and artificial nourishment and dredging, selection of locality, harbour entrances, their siting, widths and depths and moorings and anchorages are also subjects dealt with in some detail. Model experiments are only lightly treated but a bibliography of recent papers and works on the subject is given. This chapter concludes with a dozen or so plans and descriptions of harbours, including the often criticised Arromanches.

Chapters 9 and 10 are devoted to Tides and Waves and Marine and Submarine Surveying respectively. In the former the author gives a survey of fundamental principles and theories relating to the origin of tides, tidal waves and tidal prediction. On the subject of sea waves the author deals at length with all the characteristics of waves including their propagation, fetch, height, etc., surface profile theories, orbital motion and mass transport. The dynamical value of breaking and "clapotis" waves and the theories and experiments of Benedit, Sainflou, Cagli, Bagnold and others are closely examined. Seiche and harbour surging and its influence on harbour design are other subjects discussed. Marine and Submarine Surveying is a subject which in all its aspects is also a lengthy one but an informative summary has been compressed into about twenty pages. Instruments and methods of surveying and plotting are described, including an account of the principles of echo-sounding, while visual and recording tide gauges and the determination of the strength and direction of currents and water sampling are discussed at length. Recent application of radio-isotopes in tracing the movement of silt in estuaries and coastal waters is mentioned in this chapter and again in that on Entrance Channels, where a short bibliography on the subject is given.

Chapter 11 on Breakwaters and Pierheads commences with methods of reducing wave motion, classification of breakwaters, their comparative costs of construction and maintenance, efficiency and choice of type. Breakwaters are separately dealt with in all their varied forms and applications. Sections are included that deal with the stability of various types, stress distribution on foundations, subsoil consolidation, the slope of mounds and sizes of stone. Some of the recent theories of equating the height of waves, slope of structure and size and density of surface stones are also extensively discussed. A valuable section of this chapter is the series of examples of breakwaters and of wave action. Commencing with Madras Harbour, which by early failures and subsequent modifications has provided experience from which many valuable lessons have been learned, the author leads on to full analyses of the failures of breakwaters, among others Alderney, Catania, Algiers, Leixoes and Genoa. Floating breakwaters of the type employed at Arromanches and pneumatic breakwaters are also discussed. This chapter is complementary to Chapter 8 and read in conjunction with it and Chapter 2 of Volume 1, upwards of sixty examples of harbours and breakwaters will be found. If fault can be found in this chapter it is that more of the illustrations of breakwater structures should have been dated for easier reference. Construction of breakwaters be it noted is to be dealt with in volume 4.

Jetties, Piers and Landing Stages are dealt with in Chapter 12, the principle features being the bearing power of piles; cylinder, screw pile and screw cylinder construction; impact on jetties, and the effect of raking piles. A somewhat fuller treatment of groups of piles would have been beneficial. A number of examples are given of jetties of many forms built during the last decade including those designed in accordance with the most modern conceptions of light piling with rakers and heavy deck systems. Some important landing stage examples are illustrated and described and a useful section is that concerning the stability and design of floating pontoons. This chapter might have been a suitable place to include the design and construction of piled mooring dolphins but it appears that these structures and examples of large hollow cored pile construction will be dealt with in volume 4.

Entrance Channels and Channel Demarcation are the subjects of Chapters 13 and 14. The former contains discussions of the variable conditions and features of tidal entrance channels, helical flow and erosion, the mechanism of silt movement and deposit, and accretion in estuaries. The various methods of river improvement, training and regulation are examined at length. Wave traps and spending beaches and estuarial models are also referred to. Training by means of dredging is discussed but the subject of dredgers and dredging is to be dealt with more fully in volume

3. The causes of failure of sea walls and revetments for coast protection and the various modern methods of protection in the light of the experience of many authorities are discussed. Chapter 13 concludes with descriptions and plans of channel regulation works, and gives such notable examples as those at Ostend, New York Harbour, the Seine below Rouen, the Loire, Mersey, Thames, Mississippi, Southampton Water, Yangtse Kiang, Whangpoo, Clyde and Dee. The table of references and bibliography contains forty-two items relating to the above subjects.

In the final chapter, number 14, the general principles of Channel Demarcation and Buoyage, the Universal and Cardinal systems, the lighting of buoys, audible signals, radio and radar systems, visual beacons, lighthouses, light beacons and light vessels are described and illustrated. The chapter concludes with a short section on ship and buoy moorings.

The format of this volume follows that of the previous one and the production as a whole is admirable. The enthusiasm of the author in his subject is obvious and he must be commended for his zeal in undertaking this extensive work of reference for the benefit of dock and harbour engineers.

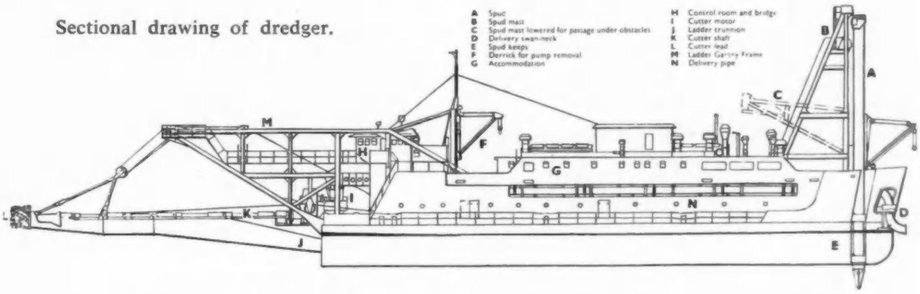
Manufacturers' Announcements

New Cutter Suction Dredger

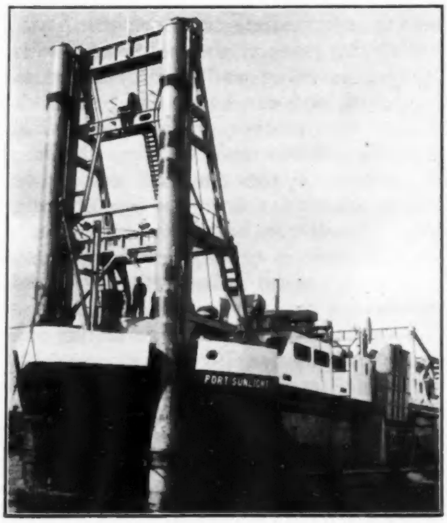
A new dredger named the "Port Sunlight", constructed by the Westminster Dredging Co. Ltd., at their workshops at Bromborough Dock on the River Mersey, was recently demonstrated at Liverpool. The "Port Sunlight" has been designed to cut soft and medium hard rock as well as to operate in granular materials within the normal range of less powerful cutter suction dredgers. The softer rocks are well within the capabilities of the new dredger and such materials as coral and hard sandstone, which would normally be dredged after breaking with a Lobnitz type breaker, can be dealt with more economically and faster by this dredger.

The "Port Sunlight" operates in a similar manner to any other cutter suction dredger by rotating in an arc about one spud and disposing of dredged material ashore by means of a floating pipeline. It is designed to work in depths up to 65 ft of water and can remain in a tideway on its spuds in an even greater depth. In addition to spuds, the dredger carries a stern mooring arrangement which permits staying in position in a tideway when the limit of the spuds is exceeded. A brief specification is as follows:—The cutter incorporated on the dredger is 8 ft in diameter and has 6 blades, each carrying 7 teeth. Power to the cutter head is supplied by a variable speed submersible electric motor of 1250 h.p. which is mounted on the after part of the ladder carrying the cutter head. This motor is designed to operate at a tilt of up to 50°.

View of Cutter head.



Sectional drawing of dredger.



View of the Spuds

The main pump is a centrifugal unit with 27 in suction diameter delivery. The pump is installed in a well isolated from the remainder of the hull, and the access hatch in the upper deck permits the removal of the complete pump unit for overhaul and replacement by a second pump.

The main engine is a turbo-charged 16 cylinder Mirrlees type KVSSA.16 having a rated output of 3850 h.p. at 375 revolutions per minute. Higher revolutions and greater output are permitted for short periods. It drives the pump through a Lohmann coupling and Kingsbury bearing.

The cutter motor is served by a 1000 kW generator powered by a turbo-charged Mirrlees engine developing 1673 h.p. Winches, etc., are served by a 562 kVA alternator and a 175 kW generator driven by a Mirrlees engine developing 863 h.p. For use when in port an engine developing 330 h.p. and driving a 219 kVA alternator has been incorporated.

The spuds are 84 ft in length and each weighs 34 tons. They are located in spud keeps at the stern and are raised and lowered by winches of special design.

The control of the dredger is centralised on the bridge. A console type panel features Westinghouse pneumatic controls, giving the dredgermaster fingertip control.

Cabins are provided in the superstructure for a crew of 21 and are insulated from the engineroom to minimise noise. There are two messrooms aboard, a large galley, cold stores and wash rooms with showers, etc. Mechanical ventilation and central heating are provided throughout.

The hull dimensions are:— Length overall, 168 ft; Beam, 42 ft; Depth, 12 ft. The hull has been specially designed to permit the dredger to be towed stern first when proceeding overseas. This has been done by providing a bow-like structure at the stern.

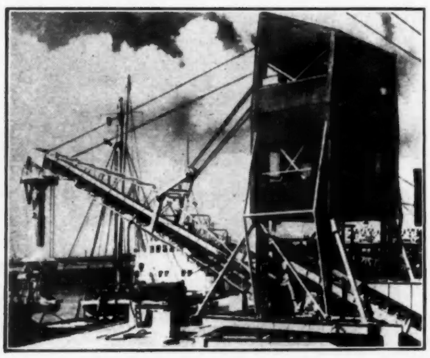
New Bulk Cargo Loader

The C. & T. Bulk Cargo Loader illustrated below has proved to be a rapid and efficient means of loading salt into ships at the Weston Point Works, of Messrs. Imperial Chemical Industries Limited, (Salt Division), Runcorn.

The equipment is mounted upon wide gauge rails which run the length of the loading wharf and the super-structure supporting the conveyors is mounted upon a power operated turntable.

The salt is loaded into the feeder conveyor from the adjacent store by mobile shovels. Alternatively, it can be brought by lorry from distant storage areas and tipped directly into the feed hopper. The feed hopper belt, 6 ft in width, is rubber covered and the feeder is provided with retracting gear to clear the 60 ft main conveyor boom when it is raised to maximum height when not in use.

The upper floor of the tower is the control room from which all operations are effected by one man by means of push buttons, and full safety precautions are included throughout in the shape of automatic trip and over-run switches.



A C. & T. Meteor Thrower is suspended from the 60 ft conveyor and this is provided with independent elevating gear operated from the control room. Fibreglass telescopic chutes are provided to guide the salt into the thrower, and an effective ball thrust ring encircles the feed chute and permits free rotation in the hold, by means of hand lines which can be controlled by one man.

The equipment which was manufactured by Crone & Taylor (Engineering) Limited. St. Helens, Lancashire, handles salt easily at the rate of 300 tons per hour.

Plastic Buoy Developments

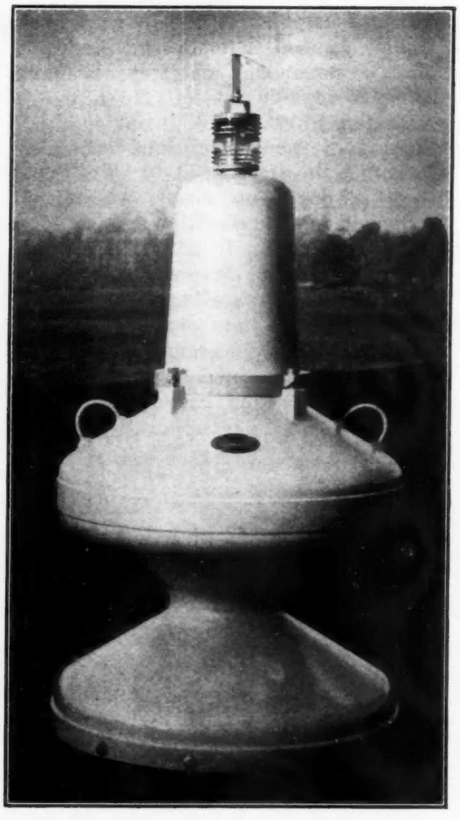
One of the latest and most interesting additions to the range of marine lighting equipment is a small lighted marker buoy 3-ft. in diameter and constructed in glass reinforced polyester resin material. It has been introduced by Chance-Londex, Ltd. The rather unusual "Diabolo" underwater shape achieves several improvements in buoys of this size:

(a) Centralised water pressure about the mooring eye ensures that the buoy remains upright even in strong currents.

(b) The lower skirt exercises a pronounced damping effect on buoy movement in choppy water.

(c) The buoy stands upright on shore for easy servicing.

(d) Reduced underwater displacement is necessary when using this lighter weight material and the design achieves this in combination with the properties above.



It is considered that small buoys in particular benefit from the corrosion free properties of polyester resin. The alternative thin steel sheet sometimes employed needs constant care if it is to be kept reasonably free from corrosion, especially in places awkward to clean and repaint.

The N.P.3. buoy, as illustrated, is fitted with a quick flashing (60 per minute) light and has a luminous range of about 2 miles red and 1—1½ miles for white or green in clear weather. Due to the remarkably low consumption of the light, the dry primary batteries—of a freely available pattern—will run the unit continuously for 6 to 8 months.

For convenience, the small winker mechanism and the battery assembly are made up in the form of a pack held in a central tube in the body. The pack can be easily removed and changed over as a single complete unit. The lighting equipment employed is taken from the standard range of Chance-Londex Winker Beacons which have been widely used for marking duty since their introduction ten years ago.

The buoy, for which a Patent is being sought, can be finished in almost any desired colour but the standard production is in brilliant orange giving an outstanding impression of contrast with a sea or shore background.

N.S. 70 Mobile Crane

R. H. Neal and Co., Ltd., Ealing, London, recently exhibited at the British Trade Fair, Lisbon, their Type NS. 70, pneumatic-tyred, self-propelled, Mobile Crane of 6 tons maximum capacity which is used extensively at ports. A wide range of jibs are supplied for various classes of work, and the crane shown was fitted with a 50-ft. straight lattice jib, giving a maximum lift of 2 tons at 18-ft. radius up to a height of 47-ft. The jib can be shortened by removing intermediate sections.

With this crane all the motions (hoisting, slewing, travelling, and derricking) are independent, and can be operated singly or in any simultaneous combination, which gives efficient and rapid working. Hydraulic control of the clutches, and power assisted steering, also ensure ease of operation. Loads can be slewed continuously in a full circle in either direction, which is particularly useful when grabbing or requiring high output.

A special free wheel device in the road wheel transmission gives manœuvrability and ease of travelling. A special hoist unit system combines maximum safety with complete control of the load and precise lowering.

This model can be supplied on crawler tracks, mounted on motor truck, or with fixed base.

Dual Purpose Tug

A new diesel-electric tug 'Cardon', built in the Renfrew shipyard of Lobnitz & Co., will shortly be going into service at the Shell Oil Refinery at Cardon, Venezuela. The vessel which has been designed for the berthing of Super tankers and fire fighting, has an overall length of 114-ft, breadth moulded of 29-ft. and a depth moulded of 14-ft.

Diesel-electric tug "Cardon".

The outstanding feature of the craft is the high manoeuvrability at slow speeds, derived from a Pleuger activated rudder. This rudder which can be moved 90° port or starboard during slow speed manoeuvring, is fitted with a 100 h.p. motor and propeller operating in a centrally positioned streamlined nozzle. The thrust developed by this propeller can be used to give a strong steering impulse to the vessel even when insufficient way exists for normal steering action. Power for this operation is supplied by an alternator driven by a Rolls Royce diesel engine.

As the vessel will operate under tropical conditions a comprehensive system of mechanical ventilation has been installed throughout the vessel by Thermotank Ltd.

Main propulsion machinery consists of two Mirrlees oil engines coupled to Metropolitan-Vickers main generators driving a double-armature electric motor to give 1,000 s.h.p. at 150 r.p.m.

Fire-fighting equipment, which is mounted on the boat deck and on a platform over the funnel cowling, is driven direct from the machinery without interrupting the manoeuvring of the vessel, and consists of four monitors. Two electrically-driven fire pumps can discharge water at 150 lbs. per sq. in. pressure at a rate of 3,300 gallons per minute. Tanks holding 3,000 gallons of foam compound are fitted on board to deal with oil fires.

The single-screw tug achieved a speed of 12¾ knots on acceptance trials. A bollard pull of 15 tons with maximum power at 120 r.p.m. was recorded for towing.

Salvage and Workshop Barge

Richard Dunston Limited recently completed at their Thorne Shipyard a Salvage and Workshop Barge ordered by British Waterways for operation on the Gloucester/Sharpness Canal and the River Severn between Gloucester and Stourport.

The vessel of welded construction has been designed with a view to obtaining a versatile unit capable of undertaking the salvage of sunken craft, the installation of lock gates, pile driving and the erection and maintenance of civil engineering works on the river and canal banks.

Principal Details

Length O.A.	82-ft. 0-in.
Breadth Mld.	19-ft. 6-in.
Depth Mld.	8-ft. 0-in.
Maximum Cathead Lift	50 tons
Maximum Sheerleg Lift	20 tons
Pumping Capacity ...	150 tons/hr.

The hull is of rectangular form divided by bulkheads into aft peak ballast space, generator and pump room, messroom, hold and workshop fore peak ballast space.

Three types of lifting have been arranged. Twin sheerlegs are fitted forward, each capable of lifting an S.W.L. of 10 tons and so arranged that with a spreader beam a 20-ton lift of 23-ft. 6-in. can be made. The spreader beam is fitted with additional lifting lugs between the centre and points of attachment to the sheerlegs so that offset lifts of under 20 tons can be made. The lifting is by means of a single wire from the barrels of a 10-ton winch located in the hold. The port and starboard barrels operate separately or simultaneously. Luffing of the sheerlegs is accomplished by a back haul over treble blocks from the barrels of a 12-ton winch fitted on the after deck. The two winch barrels can be operated independently or together. When not required or when being towed the sheerlegs are lowered on to crutches on the deck. The raising and lowering of each sheerleg is carried out independently of all other lifting facilities either on other vessels or on shore, both winches are arranged to work in unison so that when the luffing winch is pulling the sheerleg back to lower, the hoist gear is shackled to a permanent anchorage on the barge and when the sheerleg is past the point of balance it is then fully under control of the hoist winch for lowering. The reverse procedure is used to raise each sheerleg.

Retractable catheads are fitted P. and S. at the fore end of the barge, each cathead is capable of lifting 25 tons and when combined by means of a second spreader beam a 50-ton lift can be obtained. The 25-ton wires running over the cathead sheaves are secured to the treble blocks handled by the 12-ton winch.

A 3-ton steel derrick 30-ft. long and capable of operating through 180° is fitted to a derrick post on the centreline. The lifting and topping wires are worked from the warping drums on the 12-ton winch. Screw down compressors and double post bollards for holding the wires are arranged on deck adjacent to the winch.

The 10-ton and 12-ton winches were supplied by Messrs. Clarke, Chapman and Co. Ltd. and each is driven through the latest disc type coupling by a Lister FRMA diesel engine of 24 and 36 b.h.p. respectively arranged for electric starting and radiator cooling.

In addition to the power drive the winches are fitted with hand operating gear which, as well as being for emergency use, permits positioning of difficult loads such as lock gates with a very fine degree of control.

The 150 tons/hr. Hamworthy B4 centrifugal pump for salvage and ballast duties is flexibly coupled to a 16 b.h.p. Lister. A 6 b.h.p. Lister air-cooled diesel engine drives a 3-Kw. 110-v. D.C. generator which supplies lighting and power throughout the vessel. Provision is made throughout the hold and on deck for the use of portable tools from the numerous power points provided.

Salvage and Workshop Barge.

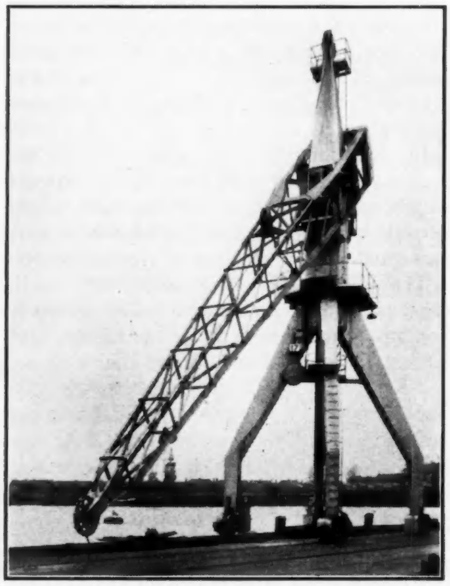
A spacious messroom is arranged below deck aft and is fitted with galley range, table and seating etc. A lobby gives access to the generator and pump room and the hold.

In due course it is intended to fit out the barge hold as a workshop complete with welding and compressed air plant etc. so that maintenance work of a wide nature can be carried out on the site.

New Dutch Crane

A crane called the "Leptoptilus" was recently introduced by Holland Cranes, The Hague, Holland. This new type embodies various novel features, and has been designed after 14 months' study of present-day cargo handling problems.

The gantry has four legs of box section which carry the necessary ballast inside. The legs are shaped so that water cannot accumulate on them, thereby reducing the possibility of corrosion. Fork lift trucks and other mechanised equipment can pass easily under the crane as there are no low-placed horizontal connecting beams between the legs. Two of the four bogies are driven by a self-contained travelling mechanism which can be removed for servicing. This unit is fitted with a shock absorber to prevent wear of the mechanical parts.



A completely new feature of the crane is that the jib can be luffed down to the quay. This permits easy inspection of sheaves and ropes, greasing, and reeving in new ropes. (See illustration.) The jib is of riveted construction so that should a deformation to a bar occur through an accident, it can be repaired on the spot with the least loss of time.

The slewing mechanism is also designed as a self-contained unit, and the upper structure of the crane slews on and is carried by a ball race with two layers of balls for taking up pressure and pull. The advantage of this method is that ballast is not necessary in the slewing structure, thus saving weight and space. The upper structure, made of sheet steel in the shape of a box section, contains the electrical apparatus and wiring.

The luffing mechanism is built completely as a single unit and is attached to the tower at three points. A shock absorber is fitted to prevent extreme shock loads and so reduce wear, especially when starting and stopping. The crane is available in four types all with a hoisting capacity of 3 tons.

New Equipment for Dwarka Lighthouse

The Lighthouse Department of the Government of India is in the process of modernising and constructing many lighthouses, and during recent years, equipments for Okha, Mangrol, Uttan, Tolkeshwar, Puri, Perotan, Jegri and Jakhau have been supplied by Stone-Chance Ltd., England. The Company have just constructed at their new factory at Crawley the largest lighthouse they have built for many years. When installed at Dwarka, situated in the mouth of the Gulf of Kutch on the north-west coast of India, about 350 miles north of Bombay, it will be one of the most powerful lights in Asia, with a beam of 5,100,000 candlepower and a range in clear weather of some 45 sea miles.

The large two-panel prismatic glass lens revolves on a mercury support, the power of rotation being provided by a weight-driven machine rewound automatically by an electric motor. Light from the 3,500 watt lamp is condensed into two beams set to provide two flashes in a group recurring every 20 seconds. Two lamps are employed —one being lit and the other in reserve. If the lamp in service fails the other automatically swings into focus and lights up. The whole apparatus is to be housed within

The 10-ft. 6-in. dia. lantern which will house the optical apparatus shown in background.

the 10-ft. 6-in. diameter lantern upon the tower now being constructed by the Indian Government. Local mains electricity will supply the lighthouse but, if this fails, a standby diesel generator plant of Stone-Chance construction will start automatically and restore power to the apparatus and lightkeepers' dwellings.

The value of the equipment is approximately £22,200 and, after inspection, it will be stripped, packed and shipped to Bombay.